Designation:	SIRCO SERIES B/DP-VS
Manufacturer:	Sirco Controls Company 8815 Selkirk Street Vancouver, B.C. Phone 261-9321
Sampler Intake:	Provided by user. Sampler has 5 cm (2 in.) inlet pipe.
Gathering Method:	External head to provide flow through sampler and back to sewer. On signal a liquid diverter mechanism is energized and sample is drawn into a metering chamber. After the desired amount of sample is obtained, a solenoid pinch valve at the bottom of the metering chamber is actuated and the sample is discharged by gravity into the sample jar.
Sample Lift:	Not applicable.
Line Size:	Smallest line size appears to be about 0.95 cm (3/8 in.) tube leading to sample jar.
Sample Flow Rate:	Depends upon user's installation; no recommended minimum.
Sample Capacity:	Sample metering chamber adjustable from 50 to 500 mℓ (500 to 1000 mℓ optional); either composited in 7.6, 11.4, or 18.9ℓ (2, 3, or 5 gal) jars or sequential in either 12 or 24 jars of either 1/2 or 1 liter capacity.
Controls:	Available with built-in timer for pre-set time interval (3 min to 45 hrs) sampling or for connection to external flowmeter for flow proportional sampling or both. Automatic jar full shut-off.
Power Source:	Either 110 VAC or 12 VDC lead zinc or nickel cadmium battery or combination.

Sample Refrigerator:	Available with thermostatically controlled refrigerated sample component.
Construction Materials:	Sampling train is stainless steel and plastic; weatherproof steel enclosure standard; all stainless steel construction available.
Basic Dimensions:	Same as B/ST-VS.
Base Price:	Varies from under $1,600 to around $3,000 depending upon features desired.
General Comments:	This unit was designed for installations where the sampler must be some distance, say more than 100 feet, from the sample pick-up point. It is recommended by the manufacturer for treated sewage or final effluent.

Sirco Series B/DP-VS Evaluation

1. Diverter mechanism could be subject to clogging (manufacturer only recommends unit for treated sewage or final effluent). Sampling intake must be designed by user.

2. Sampler itself offers no flow obstruction.

3. Should be capable of operating over entire range of flow conditions.

4. Movement of solids should not hamper operation.

5. No automatic starter. Continuous flow serves a self-cleaning function and should reduce cross-contamination.

6. Can collect flowmeter or timer paced samples either discrete, sequential, or composite. Representativeness of sample will depend upon design of sampling intake which is not a part of this unit.

7. Unsuitable for collection of floatables or coarser bottom solids.

8. Automatic refrigerator (adjustable temperature) available. Offers good sample protection but vulnerable to slight cross-contamination in sequential mode.

9. Specifically designed for installation remote from sample pick-up point. Not suitable for manhole operation.

10. Cannot withstand total immersion.

11. Thermostatically controlled heater and fans are available for applications in freezing ambients.

12. Operating head is provided by user.

Designation:	SIRCO MODEL MK-VS
Manufacturer:	Sirco Controls Company 8815 Selkirk Street Vancouver, B.C. Phone 261-9321
Sampler Intake:	Weighted end of sampling tube installed to suit by user.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6.7m (22 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Up to 6 ℓps (1.6 gpm) depending upon lift.
Sample Capacity:	Sample volume adjustable between 25 to 500 mℓ (repeatable to within ±0.5 mℓ); composited in 15.1ℓ (4 gal) container or sequential or discrete in 24 500 mℓ containers.
Controls:	Adjustable chamber slide electrode controls sample volume. Built-in timer allows adjusting sample cycle from 3 minutes to 45 hours. Option allows pacing by external flowmeter. Automatic shut-off.
Power Source:	110 VAC or 12 VDC lead-acid or nickel cadmium battery.
Sample Refrigerator:	Ice compartment allows some sample cooling. Automatic refrigerator available.
Construction Materials:	Sample train is PVC, plexiglass, and stainless steel. Case is weatherproof aluminum.
Basic Dimensions:	41 x 41 x 56 cm (16 x 16 x 22 in.); weighs 16.8 kg (37 lbs) without battery. Portable.
Base Price:	Around $1,300 and up depending upon features desired.

General Comments: Signal from timer starts vacuum/compressor pump. Compressor side of pump purges sample intake tube, sequence changes and vacuum side of pump evacuates metering chamber and draws desired amount of sample. Compressor side of pump then discharges sample into sample container. Should plugging of the sampling tube occur, the pump is switched to the compressor side to blow out the tube. This sequence is repeated until the desired amount of sample is collected. Purging also takes place before and after each sample is taken.

Manufacturer states that the unit is especially designed to sample untreated raw sewage or high consistency industrial waste containing rags, fibers, etc.

A low cost Model MK-5, which collects up to 150 adjustable size (25 to 150 mℓ) aliquots and composites them in a 3.8ℓ (1 gal) jug, is also available. It does not have power-purge but uses similar controls as MK-VS units. Measuring 43 x 25 x 56 cm (17 x 10 x 22 in.) and weighing 19 kg (42 lbs), the unit can lift up to 6m (20 ft) through its 0.64 cm (1/4 in.) I.D. intake tube.

Sirco Model MK-VS Evaluation

1. Should be fairly free from clogging due to lack of bends and fittings in sample train and high pressure purging feature.

2. Obstruction of flow will depend upon way user mounts the end of the sampling tube.

3. Should operate equally well over the entire range of flow conditions.

4. Movement of solids should not hamper operation.

5. Automatic starter available. Power purge serves a self-cleaning function. Cross-contamination should be minimal.

6. Can collect external flowmeter or built-in timer paced samples either composite or discrete or sequential. Representativeness of sample will depend upon user mounting of intake tube.

7. Unsuitable for collection of floatables or coarser bottom solids without special designed intake by user.

8. Unit affords good sample protection; case has ice cavity which will provide cooling for a limited time; automatic refrigerator available. High pressure purge features should offer reasonable protection against cross-contamination.

9. Designed to operate in manhole area.

10. Cannot be totally immersed.

11. Cannot withstand freezing ambient.

12. Maximum lift of 6.7m (22 ft) does not place a severe restriction on use of unit.

Designation:	SONFORD MODEL HG-4
Manufacturer:	Sonford Products Corporation 100 East Broadway, Box B St. Paul Park, Minn. 55071 Phone (612) 459-6065
Sampler Intake:	Parabolic port in a 1.9 cm (3/4 in.) I.D. rigid tube.
Gathering Method:	Mechanical; sampling tube is rotated down into the flow where it fills through the port by gravity; an electric motor rotates the tube up and the sample flows by gravity into the container.
Sample Lift:	Telescoping sampling tubes may be adjusted to reach down to 53 cm (21 in.) from the bottom of sampler.
Line Size:	1.9 cm (3/4 in.) I.D.
Sample Flow Rate:	Varies with tube angle.
Sample Capacity:	Varied aliquot sizes of 10, 20 or 30 mℓ are composited in a single 3.8ℓ (1 gal) container.
Controls:	Sampling cycle may be triggered at preset time intervals from built-in electrical timer or on signal from external flowmeter.
Power Source:	110 VAC standard; battery optional.
Sample Refrigerator:	Has ice cavity for cooling.
Construction Materials:	Aluminum outer case with rigid insulation.
Basic Dimensions:	33 x 31 x 33 cm (13 x 12 x 13 in.) plus clearance for oscillating sampling tube which varies depending upon telescoping adjustment. Portable.
Base Price:	$325 electric; $495 with battery.

Sonford Model HG-4 Evaluation

1. Does not appear capable of sampling a particle large enough to clog it; could be affected by rags or paper; no pump to clog.

2. Sampling tube presents a flow obstruction during sampling period only.

3. Low sampling velocities make representativeness of samples questionable at high flow rates. Does not appear tolerant of variable depth flows.

4. Unless mounted so that sampling tube oscillates in flow direction, large solids could cause damage. Appears susceptible to fouling by stringy materials which could wrap around sampling tube.

5. No provision for automatic starting. No self-cleaning features.

6. Collects fixed size samples at either preset time intervals or on signal from external flowmeter and composites them in a single container.

7. Appears unsuitable for collection of samples of either floatable materials or coarser bottom solids.

8. Provision for ice cooling affords some sample protection for a limited time. Limited lift may require placing sampler in a vulnerable location. Cross contamination appears very likely.

9. Unit has a small case but requires clearance for oscillating sampling tube. Case has unsealed opening for movement of same.

10. Unit cannot tolerate submersion.

11. No standard provision for heating case. Ice buildup in sampling tube appears a real possibility.

12. Limited lift and restrictions on liquid level variations severely limit range of operating head conditions

Designation:	STREAMGARD DISCRETE SAMPLE ATTACHMENT MODEL DA-24S1
Manufacturer:	Fluid Kinetics, Inc. 3120 Production Drive Fairfield, Ohio 45014 Phone (513) 874-5120
Sampler Intake:	Not applicable.
Gathering Method:	Pump or liquid composite sampler provided by user.
Sample Lift:	Not applicable.
Line Size:	0.6 cm (1/4 in.) I.D.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Twenty-seven, 473-mℓ bottles are sequentially filled at hourly intervals.
Controls:	None.
Power Source:	Spring driven clock.
Sample Refrigerator:	Refrigerated sample storage optional.
Construction Materials:	Sampling train is all plastic, mostly PVC; case is aluminum with epoxy paint finish.
Basic Dimensions:	48 x 30 x 50 cm (18x12x20 in.); portable.
Base Price:	$775.
General Comments:	This unit is actually a sample delivery subsystem rather than a complete sampler. The sample container tray slides easily out of the cabinet and the tray cover, which has a carrying handle, seals the containers when snapped into position. Since the tray is provided with segmented dividers,

individual bottles may be removed during the sampling period without disturbing the sequence of the other containers. Since it is not a complete sampler, no evaluation will be given.

Designation:	TMI FLUID STREAM SAMPLER
Manufacturer:	Testing Machines, Inc. 400 Bayview Avenue Amityville, New York 11701 Phone (516) 842-5400
Sample Intake:	Stainless steel hollow cylindrical body with a 2.5 cm (1 in.) inlet and mounted submerged in the stream either on four legs mounted to a bottom plate or suspended from above if in a weir or flume.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Over 7.6m (25 ft); depends upon air pressure.
Line Size:	1.3 cm (1/2 in.) O.D.
Sample Flow Rate:	Depends upon air pressure and lift.
Sample Capacity:	Aliquots of approximately 1/2 liter are composited in a suitable container provided by user.
Controls:	User must provide air pressure regulator if plant air supply is not regulated; sampling interval timer is adjustable to allow from one minute to one month to elapse between aliquots; manual on-off switch.
Power Source:	Compressed air supply of at least 1.4 kg/sq cm (20 psi), 7 kg/sq cm (100 psi) maximum; 110 VAC.
Sample Refrigerator:	None
Construction Materials:	Stainless steel and plastic.
Basic Dimensions:	Largest element will be user supplied sample container; sampling intake 10 x 23 x 20 cm (4 x 9 x 8 in.); timing controller 30 x 18 x 38 cm (12 x 7 x 15 in.).

Base Price: Around $800.

General Comments: Sampler developed by International Paper Company for use in the paper industry for checking the loss of useable fiber in effluent, taking consistency samples, etc. Sampler has performed well in flows to 6,800 ℓpm (1800 gpm) and consistencies to 3.5%.

TMI Fluid Stream Sampler Evaluation

1. Sampler should be free from clogging.
2. Sampler intake offers rigid obstruction to flow.
3. Sampling chamber will fill immediately following end of previous sample. Circulation through chamber would appear to be limited, resulting in a sample not necessarily representative of conditions in the sewer at the time of next triggering signal.
4. Movement of small solids should not affect operation; large objects could damage (or even physically destroy) the in-water portion unless special protection is provided by user.
5. No automatic starter; no self-cleaning features.
6. Collects fixed size spot samples and composites them in a suitable container; a three minute cycle interval will deliver approximately 230ℓ (60 gal) in 24 hours.
7. Unsuitable for collection of either floatables or coarser bottom solids without special intake designed by user.
8. Sample container provided by user.
9. Not designed for manhole operation.
10. Cannot withstand total immersion.
11. Unit should be capable of operation in freezing ambients.
12. Upper lift limit determined by air supply pressure.

Designation:	TMI MARK 3B MODEL SAMPLER
Manufacturer:	Testing Machines, Inc. 400 Bayview Avenue Amityville, New York 11701 Phone (516) 842-5400
Sampler Intake:	Twelve 0.64 cm (1/4 in.) I.D. vinyl sampling lines are connected to individual ports in a stainless steel sampling head (approx. 10 cm dia) fitted with a stainless steel filter having approximately 930 0.3 cm (1/8 in.) diameter holes.
Gathering Method:	Suction lift from vacuum in evacuated sample bottles.
Sample Lift:	Sample size reduced as lift increases; 3m (10 ft) appears practical upper limit with 592 mℓ (20 oz) bottles.
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	Varies with filling time, atmospheric pressure, bottle vacuum, sample lift, etc.
Sample Capacity:	12 "Medicine Flat" glass bottles are provided. Sample sizes up to 400 mℓ can be obtained depending upon lift, bottle vacuum and atmospheric pressure; 300 mℓ is typical.
Controls:	A spring driven clock rotates an arm which trips line switches at a predetermined time interval triggering sample collection. Sampling intervals of 1/2 to 8 hours are available.
Power Source:	Spring driven clock.
Sample Refrigerator:	None.
Construction Materials:	PVC coated, light alloy case with; glass bottles with rubber stoppers and rubber lines through switch

	plate, plastic connectors and vinyl lines to stainless steel sampling head.
Basic Dimensions:	37 cm (14.5 in.) diameter x 66 cm (26 in.), empty weight is 14.5 kg (32 lbs); portable.
Base Price:	$595 including vacuum pump. Mark 4B model has 24 bottles at $685 for 592 mℓ (20 oz) size and $695 for 1 liter size.
General Comments:	This unit was originally developed by the Water Pollution Research Laboratory in England and is manufactured by North Hants Engineering Co. Ltd. under license from the National Research Development Corporation.

TMI Mark 3B Model Sampler Evaluation

1. Sampling head is vulnerable to blockage of a number of sampling ports at one time by paper, rags, plastic, etc. Sampling train is an unobstructed 0.64 cm (1/4 in.) passageway which will pass small solids. No pump to clog.

2. Sampling head and shroud are simply dangled in the flow stream to be sampled. No rigid obstruction.

3. Low sampling velocities make representativeness of samples questionable at high flow rates. Vinyl sampling tubes are exposed to flow.

4. Sampling head would appear to be vulnerable to clogging if in bed load. Stainless steel filter offers some protection against movement of solids in flow stream.

5. No automatic starter; clocks allow setting a time delay before sampling commences. No self-cleaning features. Proper cleaning of all 24 sampling lines would be difficult and time consuming in the field.

6. Collects discrete samples at preset times from a fixed point intake only.

7. Appears unsuitable for collection of samples of either floatable materials or coarser bottom solids.

8. No sample refrigeration. Limited lift may require placing sampler case in a vulnerable location. Use of individual sampling lines eliminates cross-contamination possibility.

9. Unit will pass through a 38 cm (15 in.) diameter circle. Case has base opening where sampling line bridle emerges.

10. Case will fill with fluid if submerged. Spring clock and drive mechanism then becomes vulnerable, especially if fluid contains solids.

11. No standard provision for heating case. Freezing of sampling lines appears a distinct possibility.

12. Practical upper lift limit of 3m (10 ft) poses restrictions on operating head conditions.

Designation:	TRI-AID SAMPLER SERIES
Manufacturer:	Tri-Aid Sciences, Inc. 161 Norris Drive Rochester, New York 14610 Phone (716) 461-1660
Sampler Intake:	End of suction tube installed to suit by user; manufacturer recommends using a large area screen with openings approximately 0.16 cm (1/16 in.) smaller than intake tube I.D.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Up to 7.6m (25 ft).
Line Size:	0.95 cm (3/8 in.) I.D. standard; 1.3 cm (1/2 in.), or 1.9 cm (3/4 in.) I.D. optional.
Sample Flow Rate:	500 mℓ per minute.
Sample Capacity:	Adjustable size aliquots (based upon diversion time of continuous flow from pump) are composited in a suitable container.
Controls:	Two built-in adjustable timers control sample interval (3 to 40 minutes) and diversion time (3 to 40 seconds); alternately, unit may be paced by external flowmeter.
Power Source:	115 VAC.
Sample Refrigerator:	Available as option for foot-mount models.
Construction Materials:	Sample train is tygon, silicone, PVC; case is fiberglass for portable models, weatherproof steel for wall and foot-mount models.

Basic Dimensions:	38 x 25 x 51 cm (15x10x20 in.) for basic unit without sample container; typical foot-mount outdoor model is 91 x 51 x 173 cm (36x20x68 in.); weights are 15.9 kg (35 lbs) and up.
Base Price:	$650 either portable or wall mount for use with external Tri-Aid controller; add $115 for 1.3 cm (1/2 in.) I.D. tubing, $160 for built-in timer, $60 for foot mount.
General Comments:	Units are usually sold in conjunction with flowmeters (and possibly on-line moniters) as a complete system. Diverter valve is solenoid-actuated, three-way squeeze-tube type.

Tri-Aid Sampler Series Evaluation:

1. Peristaltic action of pump and relatively large line size should reduce probability of clogging.

2. Obstruction of flow will depend upon user design and mounting of intake.

3. Should operate reasonably well over all flow conditions, but fairly low intake velocity could affect representativeness of sample at high flow rates.

4. Movement of solids should not hamper operation.

5. No automatic starter since it is continuous flow type; this will provide some self-cleaning and help minimize cross-contamination.

6. Unit collects preset size aliquots as paced by either built-in timer or external flowmeter and composites them in a user-supplied container.

7. Unit does not appear suitable for collecting either floatables or coarser bottom solids.

8. User must provide sample containers and protection for basic unit; automatic refrigeration optional.

9. Not specifically designed for manhole operation. Portable units could be so used with proper precautions.

10. Cannot withstand total immersion.

11. Not suited for prolonged operation in freezing ambients.

12. Maximum lift of 7.6m (25 ft) does not place great restriction on use of unit.

Designation:	WILLIAMS OSCILLAMATIC SAMPLER
Manufacturer:	Williams Instrument Co., Inc. P.O. Box 4365, North Annex San Fernando, California 91342 Phone (213) 896-9585
Sampler Intake:	Small diameter slitted strainer installed to suit by user.
Gathering Method:	Suction lift from diaphragm pump.
Sample Lift:	Up to 3.6m (12 ft).
Line Size:	Appears to be 0.64 cm (1/4 in.) I.D. or larger.
Sample Flow Rate:	60 mℓ per minute maximum.
Sample Capacity:	Composite container must be supplied by user. Sample volume is about one mℓ per stroke.
Controls:	Sampling rate may be adjusted from one sample per second to one every 10 minutes during operation.
Power Source:	Can be operated from any air or gas supply of 1.8 kg/sq cm (25 psi) or more or from a self-contained CO_2 bottle.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is PVC, viton, and stainless steel.
Basic Dimensions:	Not in a case; largest item is gas bottle.
Base Price:	$438; includes pump, mounting bracket, tubing with strainer and fittings, and 6.8 kg (15 lbs) CO_2 bottle.

General Comments: Maximum discharge head is 36.6m (120 ft). The only moving part is a viton diaphragm which is operated by a pneumatic oscillator to create variable sample frequency.

Williams Oscillamatic Sampler Evaluation

1. Should be relatively free from clogging.

2. Obstruction of flow will depend upon user mounting of intake.

3. Low sampling velocities make representativeness of samples questionable at high flow rates.

4. Movement of solids should not affect operation adversely.

5. No automatic starter. No self-cleaning feature. Cross-contamination appears likely.

6. Unit takes continuous composite samples paced by the Oscillamatic pulse controller and composites them in a user-supplied container.

7. Unit does not appear suitable for collecting either floatables or coarser bottom solids.

8. No refrigeration. No sample collector provided.

9. Unit appears suitable for manhole operation; however, mounting may prove difficult.

10. Unit cannot withstand submersion.

11. Unit does not appear suitable for use in freezing ambient conditions.

12. Lift limit of 3.7m (12 ft) places some restrictions on use of unit.

SECTION VII

REVIEW OF CUSTOM DESIGNED SAMPLERS

INTRODUCTION

As was noted in section VI, it has been the practice of many project engineers to custom design one-of-a-kind samplers for use in their projects due to a lack of availability of suitable commercial equipment. In this section several examples of such equipment are reviewed. Inasmuch as there is no dearth of examples, it was necessary to be rather selective in order to keep the overall size of this report within manageable bounds. Several practical considerations also favor less than 100 percent coverage. For example, no attempt has been made to dig back into history in order to examine older concepts and notions. It is felt that any good features in older designs, having proved themselves to be effective, would be incorporated in present day equipment. Furthermore, the major emphasis has been placed in recent EPA project experience.

DESCRIPTIVE FORMS AND EVALUATIONS

The same description and evaluation formats that were used for reviewing the commercially available samplers in section VI are used here with one exception. For these custom designed one-of-a-kind samplers, prices in terms of today's dollars are generally not available and, furthermore, the inevitable engineering changes that one would introduce in building equipment following a prototype would have cost impacts that are not easily assessed.

The samplers have been given names to correspond with either the developer or the project location. The descriptive forms and evaluations presented on the following pages are arranged roughly in chronological order of development, and an index is provided on page xiii.

Designation:	AVCO INCLINED SEQUENTIAL SAMPLER
Project Location:	Tulsa, Oklahoma
EPA Report No.:	11034 FKL 07/70
Sampler Intake:	Inlet tube passes through an aluminum tube which is hinged at the top of the storm drainage structure and has a polyethylene float at the other end where the inlet tube terminates with a sampling probe.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Not stated, but probably under 6m (20 ft.).
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	Not stated, but must be fairly low for inclined sequential filling scheme to be meaningful.
Sample Capacity:	Unit sequentially fills a 60 mℓ sample bottle, then a 2,000 mℓ sample bottle, and repeats this 6 times, i.e., until it has filled six 60-mℓ and six 2,000-mℓ bottles; then it collects a composite sample in a 18.9ℓ (5 gal) overflow bottle.
Controls:	A limit switch on the hinged float arm starts the pump when the flow level exceeds a preset value. When the flow level subsides the pump is shut off.
Power Source:	12 VDC marine battery.
Sample Refrigerator:	None.
Construction Materials:	Polypropylene pick-up tube, tygon and polyethylene connecting tubes, polyethylene bottles; aluminum frame, wood case.

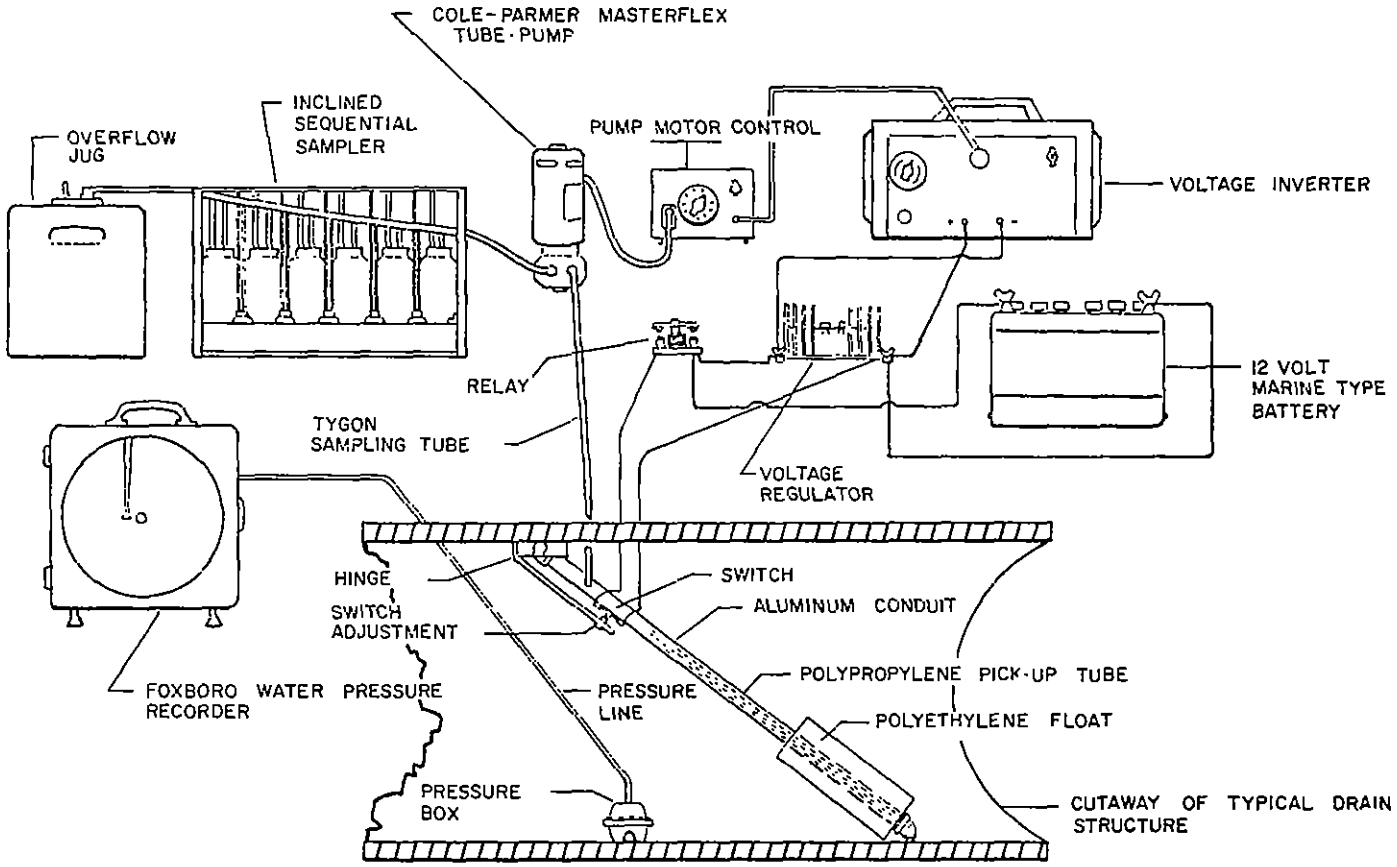

Figure 15. AVCO Inclined Sequential Sampler

Taken from EPA Report No. 11034 FKL 07/70.

Basic Dimensions: Bottle rack is 71 x 15 x 41 cm (28x6x16 in.). Both semi-stationary and portable configurations were assembled.

General Comments: A pressure box in the flow and connected to a Foxboro water pressure recorder was used. Components included a Cole-Parmer Masterflex tube pump, Model No. 7015 and a Terado power inverter (Allied No. 21f4499). The sequential filling of the sample bottles is simply performed by arranging their inlet tubes in order along an inclined manifold.

AVCO Inclined Sequential Sampler Evaluation

1. Clogging is likely in samples with high solids content due to numerous 0.3 cm (1/8 in.) obstructions in sampling train unless a filter is used; sampling probe points downstream and is near the surface due to float, but could possibly be affected by paper, plastic, etc.

2. Float and arm will be completely submerged in a full pipe flow situation and present an obstruction to flow.

3. Unit should operate over full range of flows, but low sample flow rate makes representativeness questionable for high stream flows.

4. Movement of solids in the flow stream could hamper operation.

5. Unit starts automatically when flow level rises above a preset height; no self cleaning features.

6. Sequentially fills sample bottles from output of a continuously running pump. Flow rate provides the only timing function. Samples will be representative of the near-surface water at best.

7. Unit may collect some floatables but is totally unsuited for collecting coarser bottom solids.

8. No refrigeration. Some cross-contamination is guaranteed due to filling stem arrangement, especially for 60-mℓ bottles.

9. Unit does not appear ideally suited for manhole operation.

10. Unit cannot withstand total immersion.

11. Unit is unsuitable for use in freezing ambients.

12. A 15 to 20 foot lift limit puts slight restriction on operating head conditions.

Designation:	SPRINGFIELD RETENTION BASIN SAMPLER
Project Location:	Springfield, Ill.
EPA Report No.:	11023 - - - 08/70.
Sampler Intake:	End of 280m (920 ft.) long influent line suspended 15 cm (6 in.) below water surface from a float.
Gathering Method:	Suction lift from a screw rotor pump.
Sample Lift:	Less than 4.3m (14 ft.) required in this application.
Line Size:	3.8 cm (1.5 in.) diameter lagoon influent sample intake line, 10 cm (4 in.) diameter lagoon effluent sample intake line.
Sample Flow Rate:	Approximately 15 ℓpm (4 gpm).
Sample Capacity:	Intake lines diacharged into 61ℓ (16 gal) sampling tanks. A constant volume aliquot was obtained each 30 minutes and composited in a 18.9ℓ (5 gal) container.
Controls:	A Lakeside Trebler scoop sampler was used to remove aliquots from sampling tanks. See discussion of that sampler for details.
Power Source:	115 VAC electricity.
Sample Refrigerator:	Automatic thermostatically controlled refrigerators were used to house sample containers.
Construction Materials:	ABS plastic intake lines, PVC sample bottles, sampling tank appears to be metal, pump materials not given.

Basic Dimensions:	Components are distributed within a general purpose equipment building; fixed installation.
General Comments:	Moyno pumps operating on a continuous basis were used to provide sample flow through a 61ℓ (16 gal) sampling tank. Two samplers were constructed, one for the lagoon influent and one for the effluent. Since the Lakeside Trebler sampler is evaluated elsewhere, no further evaluation of this installation will be made.

Designation:	MILK RIVER SAMPLER
Project Location:	Grosse Point Woods, Mich.
EPA Report No.:	11023 FBD 09/70
Sampler Intake:	Overflow system influent sampler intake was simply inlet of submersible pump suspended beyond the bar screens within the transition structure between sewer and wet well. Effluent sampler intake was four 2.5 cm (1 in.) vertical suction lines spaced evenly along the 64m (210 ft.) long effluent weir which drew their samples from points between the skimming baffle and weir at a depth above the bottom of the baffle and just below the outlet weir.
Gathering Method:	Forced flow from submerged pump for influent sampler; suction lift from centrifugal pump for effluent sampler.
Sample Lift:	Not stated.
Line Size:	Except for 2.5 cm (1 in.) diameter inlet lines leading to effluent sampler header, all sampling lines were 5 cm (2 in.) diameter.
Sample Flow Rate:	Not stated.
Sample Capacity:	Samplers collect adjustable grab samples from the continuously flowing 5 cm (2 in.) pipe streams, composite them for variable periods and hold them in a refrigerated compartment for periods up to about three hours.
Controls:	The size of each grab sample is controlled externally. Otherwise, the sampling program is controlled by a continuous punched paper tape

	program which varies the collection time of each composite, the number of grab samples in each composite, and each of the variables from one sampling time to another.
Power Source:	115 VAC electricity.
Sample Refrigerator:	Automatic thermostatically controlled refrigerated sample compartments.
Construction Materials:	Metal, plastic, and wood were used in construction; no details were given.
Basic Dimensions:	Indoor portion of sampler is large, perhaps 1.8x0.9x1.5m (6x3x5 ft.) or so; fixed installation.
General Comments:	This unit apparently functioned fairly well on the project for which it was designed. Since it is a custom designed, fixed installation unit no complete evaluation will be made.

Designation:	ENVIROGENICS BULK SAMPLER
Project Location:	San Francisco, California
EPA Report No.:	11024 FKJ 10/70
Sampler Intake:	A metal container resembling an inverted roadside mail box approximately 37 cm (14.5 in.) long and 36 cm (14 in.) deep with a 15 cm (6 in.) radius; hinged covers at each end are mechanically connected to function integrally upon activation of an air cylinder.
Gathering Method:	Mechanical; the sampler intake assembly is designed to fit a special support structure which must be installed in the manhole chosen for sampling. It is lowered to the bottom of the invert whereupon the covers are closed thereby trapping a plug of the combined sewage inside the sampler. The filled sampler was then raised by winch to the surface.
Sample Lift:	Depth of manhole in question. No real limit.
Line Size:	Not applicable.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Roughly 34ℓ (9 gal) maximum.
Controls:	Manually operated.
Power Source:	Compressed air.
Sample Refrigerator:	None.
Construction Materials:	Aluminum.
Basic Dimensions:	37 x 31 x 36 cm (14.5x12x14 in.) plus brackets and supporting structure, etc.

Envirogenics Bulk Sampler Evaluation

1. Unit should be free from clogging except for possibility of large debris interfering with flap closure.

2. Unit will completely obstruct flow the instant the covers are closed, but will clear as raised.

3. Since sampler must be designed for the specific manhole invert size in which it is to be used, it is suitable for all flow conditions.

4. Movement of solids in flow will not affect operation except where a significant bed load would prevent sampler from coming to rest on the invert.

5. Unit is manually operated. Cleaning is accomplished by the running sewage.

6. Sampler removes a "plug" of the sewage flow covering the entire flow cross-section.

7. Unit should sample both floatables and coarser bottom solids.

8. Unit is not suitable for sample storage.

9. Unit is designed for manhole operation, but also requires clear area above manhole for hoist and personnel.

10. Unit operates totally immersed; if manhole is surcharging sample might be less representative.

11. Unit should operate in freezing ambients.

12. Unit is indifferent to operating head conditions.

Designation:	ROHRER AUTOMATIC SAMPLER
Project Location:	Sandusky, Ohio
EPA Report No.:	11022 ECV 09/71
Sampler Intake:	Not clearly stated but presumably the end of the suction line mounted in the overflow conduit just beyond the leaping weir.
Gathering Method:	Suction lift from diaphragm pump.
Sample Lift:	Not stated but probably good for at least 6m (20 ft.).
Line Size:	Smallest line would appear to be the one connecting the diverter head to the sample container, but size is not given.
Sample Flow Rate:	Not stated but presumably rather large.
Sample Capacity:	Unit collects 24 0.47ℓ (1 pt.) discrete samples plus a flow proportional composite of up to 18.9ℓ (5 gal).
Controls:	Sampling is automatically started when the leaping weir diverts flow into the overflow flume. Discrete samples were collected every 5 minutes paced by a built-in timer adjustable from 5 to 60 minutes. Constant volume composite aliquots are added for each 37,854ℓ (10,000 gal) of flow through the overflow flume.
Power Source:	115 VAC electricity.
Sample Refrigerator:	None
Construction Materials:	Not stated.
Basic Dimensions:	None given but a fixed installation located in a building specially erected for the project.

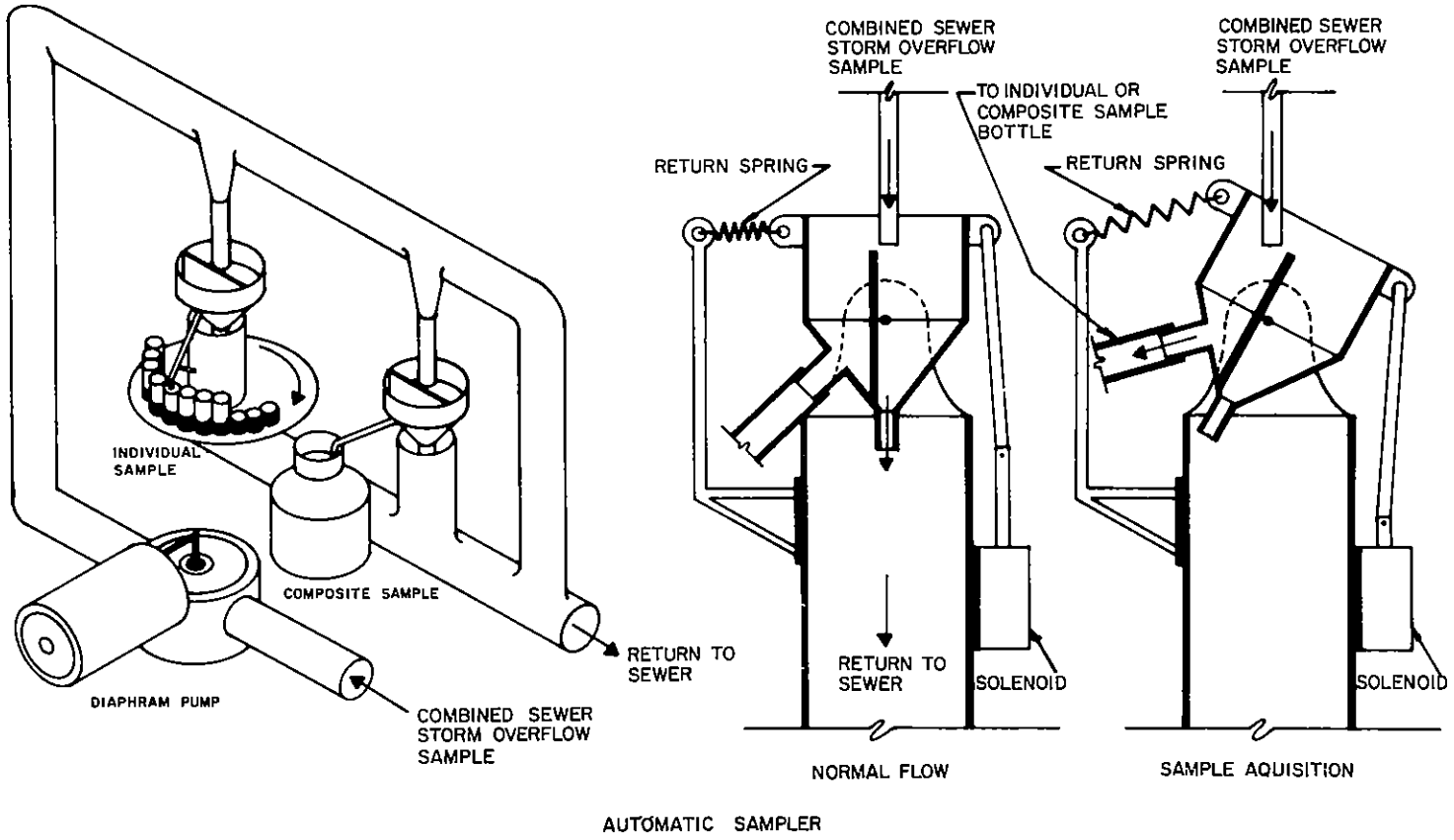

Figure 17. Rohrer Automatic Sampler

Taken from EPA Report No. 11022 ECV 09/71

General Comments: The pump produces a continuous flow of sewage through the sampling header pipe and back to the sewer. Two taps are provided to allow continuous flow through diversion nozzles for the individual and composite sample collection stations and return to sewer. When it is desired to collect a sample, a solenoid is actuated operating a linkage which mechanically rotates the diversion nozzle causing the flow to enter a chamber connected to the sample bottle rather than the sewer return. A spring assures return of the diversion nozzle to its original position after the sample is taken. The time of solenoid activation governs the size of the sample. The 24 discrete sample bottles are mounted on a turntable which indexes upon each sampling cycle to place an empty bottle under the filling spout.

Rohrer Automatic Sampler Evaluation

1. Should be relatively free from clogging.

2. Unit would not appear to offer any significant obstruction to flow.

3. Unit should be operable over the full range of flow conditions.

4. Movement of solids in the flow should not hamper operations.

5. Automatic operation. Continuous flow serves a self cleaning function.

6. Collects 24 discrete samples at pre-set time intervals and a flow proportional composite.

7. Ability to collect floatables and coarser bottom solids will depend upon details of sampling intake.

8. No refrigeration, but otherwise unit would appear to afford reasonable sample protection.

9. Unit was not designed for manhole operation.

10. Unit cannot withstand total immersion.

11. Unit would appear capable of operation in freezing ambients.

12. Relatively high lift should allow operation over a fairly wide range of operating head conditions.

Designation:	WESTON AUTOMATIC SAMPLER
Project Location:	Washington, D.C.
EPA Report No.:	11024 EXF 08/70
Sampler Intake:	Details of intake to submersible sewage pump and of sampling head to vacuum-charged sampler not stated.
Gathering Method:	Forced flow to a retention tank by a sewage pump anchored to the sewer floor, thence, by vacuum, from the retention tank to sample bottles.
Sample Lift:	Not stated.
Line Size:	Not stated.
Sample Flow Rate:	Not stated.
Sample Capacity:	Collects 24 discrete samples.
Controls:	Wastewater is pumped continuously to the retention tank. The vacuum tank is triggered by the increased back-pressure of a bubbler line resulting from the increased depth of sewer flow. The discrete interval is adjusted by an electric timer to a minimum period of 5 minutes.
Power Source:	115 VAC electricity.
Sample Refrigerator:	Sample bottles, sampling lines, and control switches installed in a refrigerated enclosure.
Construction Materials:	Not stated.
Basic Dimensions:	The wastewater retention tank, the refrigerated sampler, and the piping are all housed in 2.1 x 1.6 x 2.0m (7x5.2x6.5 ft.) metal shed.

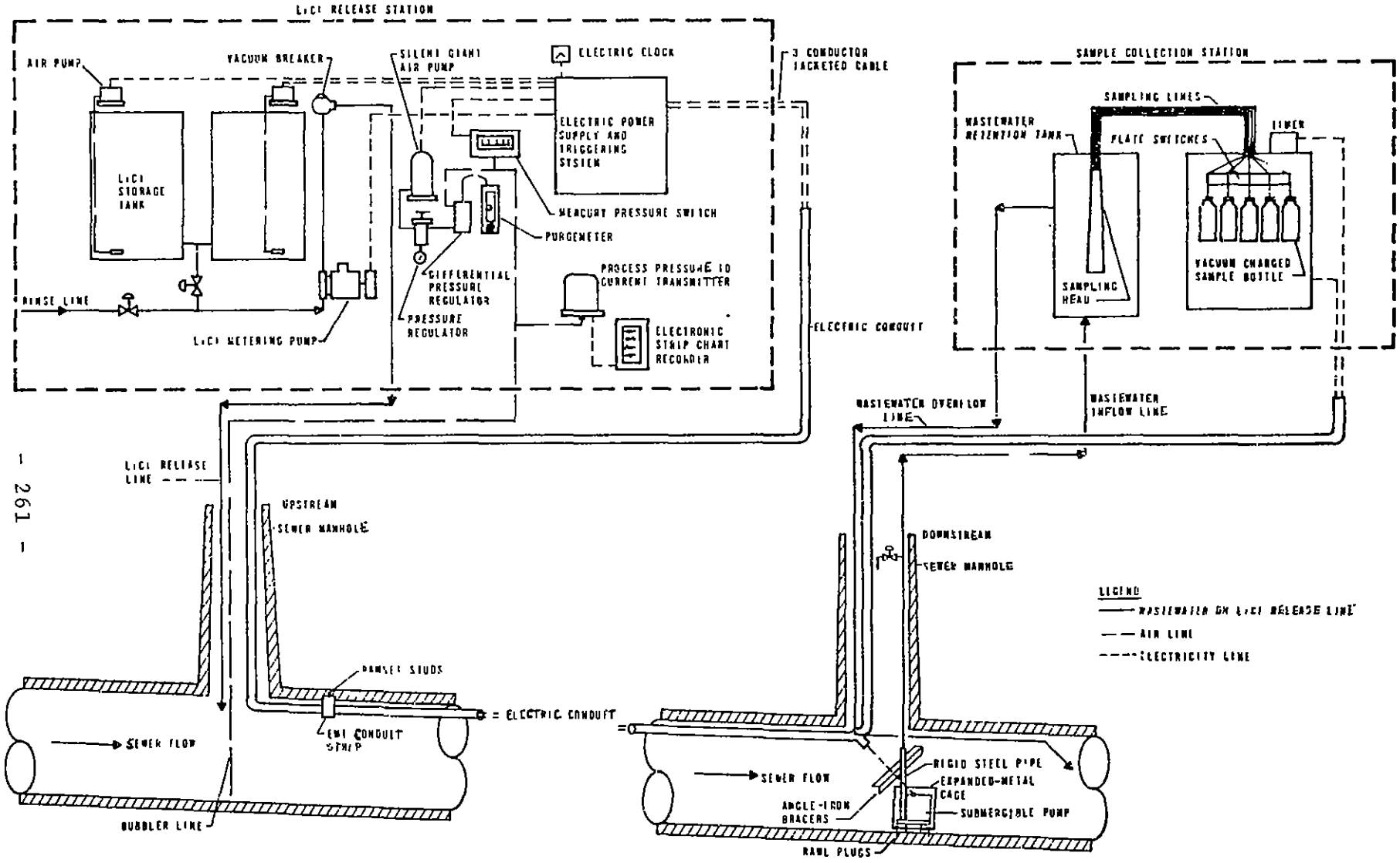

Figure 18. Weston Automatic Sampler

Taken from EPA Report No. 11024 EXF 08120.

General Comments: A submersible, heavy-duty manually-controlled sewage pump delivers wastewater continuously to a retention tank having a normal retention time of less than 1 minute. The pump is anchored to the sewer bottom in a metal cage.

During a storm, an increase of water depth in the sewer applies back pressure to an air-bubbling system, thus activating a mercury switch and triggering the system which collects samples from the retention tank. The 24 sample bottles are vacuum charged prior to the storm by use of a portable vacuum pump. The bottles are in a fixed position in the refrigerated enclosure, and each sample is drawn into its bottle by vacuum when a control switch is released by a tripper arm operated in conjunction with a timer.

Weston Automatic Sampler Evaluation

1. The submersible pump anchored to the bottom of the sewer is often clogged by solid wastes such as cans, rags, wire, wood chips, tree stems, gravel, sand, etc.

2. The submersible pump with its metal cage and angle iron braces offers a significant obstruction to flow.

3. Pump stoppages have occurred during low-intensity storms, probably because of insufficient water depth in the sewer.

4. Movement of heavy solids has caused severe damage to the equipment, to the extent that pumps have washed away.

5. Automatic operation of sampler above retention tank. Continuous flow from pump to retention tank assists in self cleaning.

6. Collects 24 discrete samples at preset time intervals. Synchronized recorded flow data permit flow proportional compositing. Samples are collected from a single elevation in the sewer.

7. Ability of unit to collect floatables or coarser bottom solids will depend upon elevation of pump intake.

8. Refrigerated sample container protects samples from damage and deterioration. Continuous flow from sewer to retention tank will help minimize cross-contamination. Sampling head and lines may be susceptible to precontamination.

9. Unit was not designed for manhole operation.

10. Unit cannot operate under a condition of total immersion.

11. Not suitable for operation under freezing ambient conditions. Could be made to operate during freezing weather by heating the metal shed housing the unit.

12. Relatively high discharge pressure would allow operation over a wide range of operating head conditions.

Designation:	PAVIA-BYRNE AUTOMATIC SAMPLER
Project Location:	New Orleans (Lake Pontchartrain), Louisiana
EPA Project No.:	11020 FAS. Final report should be available soon.
Sampler Intake:	Saran wrapped, galvanized sheet metal air diffuser about 76 cm (30 in.) long, placed about 20 cm (8 in.) below the water surface. Polyethylene tubing from intake to sampler.
Gathering Method:	Positive displacement, screw type, Moyno or Aberdenffer pump operated with a 0.56 KW (3/4 HP) motor.
Sample Lift:	Maximum suction lift about 6m (20 ft.).
Line Size:	Minimum 1.9 cm (3/4 in.) line from canal to sampler. Intake pipe to sampler manifold 1.9 cm (3/4 in.). Manifold to each row of sampler bottles, 1.3 cm (1/2 in.). Line from solenoid valve to sampler, 0.64 cm (1/4 in.).
Sample Flow Rate:	Under 11.4 ℓpm (3 gpm).
Sample Capacity:	Unit collects 36 discrete samples in bottles of about 1.2ℓ (40 oz) capacity each.
Controls:	Sampler operation initiated with manually operated switch. Filling of sample bottles controlled by a motor driven timer, through relays, to a solenoid valve at each sample bottle. Time interval between sample collections not stated.
Power Source:	Sample pump operates through a 220 volt, 60 Hz, external power source. Electrical control equipment is on a 120 volt, 60 Hz, power source.

Sample Refrigerator: Sample bottles, solenoid valves to each bottle, and sampler manifold, are installed in a Shaefer Cooler Model MC-1600, with cooling units built in its walls.

Construction Materials: Sampler piping and fittings are of PVC. Grating and supports within the cooler are aluminum.

Basic Dimensions: Outside dimensions of cooler in which sampler is installed are about 79 x 155 x 89 cm (31x61x35 in.). All equipment is installed in a 1.8 x 2.4m (6x8 ft.) shed.

General Comments: The pump produces a continuous flow of sewage to the sampler. When the sampler has been placed in operation, individual solenoid valves from the sampler manifold are opened one at a time to the 36 sample bottles by an electrically operated timer. A combination standpipe and overflow line is used to maintain pressure on the solenoid valves.

Pavia-Byrne Automatic Sampler Evaluation

1. Most clogging would be at the air diffuser inlet. Its extent would depend on the size and shape of openings in the diffuser.

2. The air diffuser intake would present some obstruction of flow, depending on where it is placed in the sewer. This would not be significant in the very large canal where the existing samplers have been installed.

3. Probably would operate at the full range of flow conditions, except at very low stages, when the air diffuser may not provide satisfactory inlet conditions.

4. Damage to the air diffuser intake may occur in storm or combined sewers of high flow velocity and heavy debris load.

5. Operation is automatic after initial startup at the beginning of a storm. Continuous flow promotes self cleaning.

6. Representativeness of sample depends on placement and configuration of the air diffuser intake. Discrete samples of uniform size collected at constant time intervals. Flow proportional compositing not possible unless time-synchronized with a recording flow meter.

7. Does not collect floatable material because the intake is set below the water surface.

8. Cooled sample container protects samples from damage and deterioration. Continuous flow from sewer to sampler minimizes precontamination.

9. Unit was not designed for manhole operation.

10. Not designed to operate under total immersion or flooding.

11. Continuous flow and insulated cooler would help permit continued operation under ambient freezing.

12. Relatively high lift would allow operation over a fairly wide range of operating head conditions.

Designation:	REX CHAINBELT, INC. AUTOMATIC SAMPLER
Project Location:	Kenosha, Wisconsin
EPA Project No.:	11023 EKC. Final report should be available soon.
Sampler Intake:	Pipe drilled with 0.63 to 0.95 cm (1/4 to 3/8 in.) holes.
Gathering Method:	Uses a "Hushpuppy" positive pressure pump. Cost of pump about $30. Operates only during a 2-3 minute purging period and during actual filling of sample bottle.
Sample Lift:	Suction lift about 4.6m (15 ft.).
Line Size:	1.3 cm (1/2 in.) Tygon tubing and garden hose.
Sample Flow Rate:	Approximately 11.4 &pm (3 gpm).
Sample Capacity:	Unit collects 18 discrete samples in bottles of 1-liter capacity.
Controls:	Sampler operation started by manually operated control. Thereafter, flow to sample bottles is regulated by an electric timer and solenoid valve. Time interval between filling of bottles can be adjusted between 3 minutes and one hour.
Power Source:	Not stated.
Sample Refrigerator:	None provided.
Construction Materials:	Sampling lines are composed of Tygon tubing and garden hose; pump is plastic and Buna N.
Basic Dimensions:	Not stated.

General Comments: After manual starting, the pump runs for 2 to 3 minutes to purge the sampler lines. The pump then operates only while each sample bottle is filled through a revolving solenoid valve regulated by an electric timer. Apparently, the pump operation is stopped automatically after 18 sample bottles have been filled.

Rex Chainbelt Automatic Sampler Evaluation

1. Experience has been only in sewage which has been comminuted and passed through a grit chamber, but unit should be fairly free from clogging.

2. The pipe sampler intake would present some obstruction of flow, the extent of obstruction depending on the method used for maintaining the position of the pipe in the flow.

3. Does not collect enough samples at short time intervals to include the entire storm period at many locations.

4. Operation impediment by the movement of solids will depend on the method used for installation of the sampler intake pipe.

5. Operation is automatic after initial startup at the beginning of a storm. Self cleaning limited to initial purging of lines.

6. Representatitiveness of sample depends on placement, and specifications of the intake pipe. Discrete samples of uniform size are collected at constant time intervals. Flow proportional compositing not possible unless time-synchronized with a recording flow meter.

7. Unit could provide some capability for floatables and bottom solids depending upon positioning and length of sampler pipe.

8. No provision for refrigeration of samples provided. Purging of lines prior to sample collection serves to reduce precontamination; cross-contamination will probably occur.

9. Unit was not designed for manhole operation.

10. Not designed to operate under total immersion or flooding.

11. Unit not designed to operate under freezing conditions.

12. Relatively high lift would allow operation over a fairly wide range of operating head conditions.

Designation:	COLSTON AUTOMATIC SAMPLER
Project Location:	Durham, North Carolina
EPA Report No.:	EPA-670/2-74-096.
Sampler Intake:	Direct intake to sump pump set on piling at stream bed. Intake from sampling flume is a standard Serco Model NW-3 sampling head.
Gathering Method:	Water pumped from stream to sampling flume with an Enpo-Cornell sump pump, Model No. 150A. Pump is placed inside a 61 x 46 cm (24x18 in.) metal box, all within a woven wire frame. A standard Serco Model NW-3 vacuum sampler gathers samples from the 91 x 27 cm (36x10.5 in.) Plexiglas flume.
Sample Lift:	About 3.3m (11 ft.) from the pump to the sampling flume. No lift from the flume to the Serco sampler.
Line Size:	Line from pump to flume is 3.8 cm (1.5 in.) fire hose. Serco sampler lines are 0.63 cm (1/4 in.) inside diameter.
Sample Flow Rate:	Flow rate from pump to flume is about 189 ℓpm (50 gpm). Flow rate from flume to Serco sampler is variable.
Sample Capacity:	24-500 mℓ bottles are provided in the Serco sampler. Actual sample sizes are about 400 mℓ.
Controls:	Operation of pump starts and stops when float in an offstream stilling well reaches specified stages. For Serco Model NW-3 sampler controls, see page 193.

Power Source:	Pump operates on 110 VAC. Serco sampler is powered with a spring driven clock.
Sample Refrigerator:	None provided.
Construction Materials:	Sampling train composed of fire hose, Plexiglas flume, stainless steel sampling head, vinyl lines, and glass bottles with rubber stoppers.
Basic Dimensions:	Not a concentrated unit. Serco sampler 39 x 39 x 68 cm (15.5x.5.5x26.7 in.).

Colston Automatic Sampler

1. Because of large diameter hose from the pump to the sampling flume, and continuous flow during the period of operation, clogging is infrequent. Experience has been in an urban stream which has the characteristics of a storm sewer.

2. The pump and covering, as placed on the stream bed, would create a significant obstruction to flow, particularly in a sewer of ordinary dimensions.

3. May not operate during very low flows, depending upon height of pump inlet above stream bed.

4. Heavy bed loads could render the pump inoperable.

5. Pump starts and stops automatically in accordance with specified water stages. Continuous flow to sampling flume provides self cleaning, but the Serco sampler has no self cleaning features.

6. Collects discrete samples at preset times from a fixed point intake only. Flow proportional compositing is possible when time is synchronized with recording flow measurement equipment.

7. Unsuitable for collection of samples of floatables or coarser bottom solids.

8. No refrigeration provided. Use of individual sampling lines in the Serco sampler eliminates cross-contamination possibility.

9. Not designed for operation in sewer manholes or other confined spaces.

10. Not operable under conditions of total immersion or flooding.

11. Would not operate under freezing conditions.

12. Sample lift of about 3.3m (11 ft.) to the sampling flume, and a potential lift of 3m (10 ft.) for the Serco sampler, indicates capability for operation under a fairly wide range of operating head conditions.

Designation:	ROHRER AUTOMATIC SAMPLER MODEL II
Project Location:	To be used in Akron, Ohio
EPA Report No.:	None
Sampler Intake:	Not clearly stated but presumably the end of the 5 cm (2 in.) I.D. suction line mounted directly in the flow stream to be sampled.
Gathering Method:	Suction lift from diaphram pump.
Sample Lift:	Not stated but probably good for at least 6.1m (20 ft).
Line Size:	1.9 cm (3/4 in.) I.D.
Sample Flow Rate:	Depends upon lift; could exceed 76 ℓpm (20 gpm).
Sample Capacity:	Unit collects twenty-four 1.9ℓ (1/2 gal) discrete samples plus an 18.9ℓ (5 gal) composite.
Controls:	Has a provision for automatic starting. Discrete samples and composite aliquots can be collected every 5 minutes paced by a built-in timer adjustable from 5 to 60 minutes. Switches automatically stop diversion to composite bottle when it is full and shut sampler off when last discrete bottle has been filled.
Power Source:	115 VAC
Sample Refrigerator:	None
Construction Materials:	Tygon and PVC tubing; aluminum diverter, nozzle, etc.; "Nalgene" sample bottles; aluminum frame.
Basic Dimensions:	137 x 76 x 150 cm (54 x 30 x 59 in.) including mounting dolly. Can be wheeled about, but appears too heavy to lift without assistance.

General Comments: The pump produces a continuous flow of sewage through the sampler diverter and back to the sewer. Two solenoids are provided to allow diversion of flow to either the discrete or composite sample container for a preset time period. They tip a nozzle inside a diversion chamber and thus direct the flow as commanded by the timing cams. The nozzle is spring loaded to return to its null position which directs flow back to the sewer. A rotating nozzle is indexed over one of 24 funnels, each connected by a piece of 1.9 cm (3/4 in.) I.D. tygon tubing to one of the wide mouth discrete sample bottles which are in a rectangular array.

Rohrer Automatic Sampler Model II Evaluation

1. Should be relatively free from clogging, except perhaps the tubes connecting the distribution funnels to the discrete sample bottles.

2. Unit would not appear to offer any significant obstruction to flow.

3. Units should be operable over the full range of flow conditions.

4. Movement of solids in the flow should not hamper operations, except for possible diaphram wear.

5. Capable of automatic operation. Continuous flow serves a self cleaning function.

6. Collects 24 discrete samples at preset time intervals and a simple composite.

7. Ability to collect floatables and coarser bottom solids will depend upon details of sampling intake.

8. No refrigeration, but otherwise unit would appear to afford reasonable sample protection.

9. Unit was not designed for manhole operation.

10. Unit cannot withstand total immersion.

11. Unit would appear capable of operation in freezing ambients.

12. Relatively high lift should allow operation over a fairly wide range of operating head conditions.

Designation:	NEAR SEWER SAMPLER
Project Location:	Tested at San Jose Water Pollution Control Plant.
EPA Report No.:	None. Not developed under EPA sponsorship.
Sampler Intake:	Small hole approximately 1.3 cm (1/2 in.) diameter in the side of a traversing pick-up tube.
Gathering Method:	Mechanical; pick-up tube with piston is lowered and fills through intake near its lower end as it traverses the stream to be sampled. Sample is ejected through a hole near the top of the tube by raising the piston inside the tube.
Sample Lift:	Will depend upon pick-up tube length; 2.4m (8 ft) would appear to be a practical maximum.
Line Size:	Smallest line (possibly 1/2") would appear to be the one connecting the sample bottle to the pick-up tube outlet.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Developer simply states that either a composite sample or a number of discrete samples can be provided.
Controls:	An upper piston was added to allow varying the quantity of samples gathered during the stream depth traverse in a controlled way. It is activated by a water surface sensor located on the bottom of the pick-up tube. The water sensor provides the capability (in conjunction with a small memory and logic unit) of gathering flow-proportional samples, at least to the extent that flow is

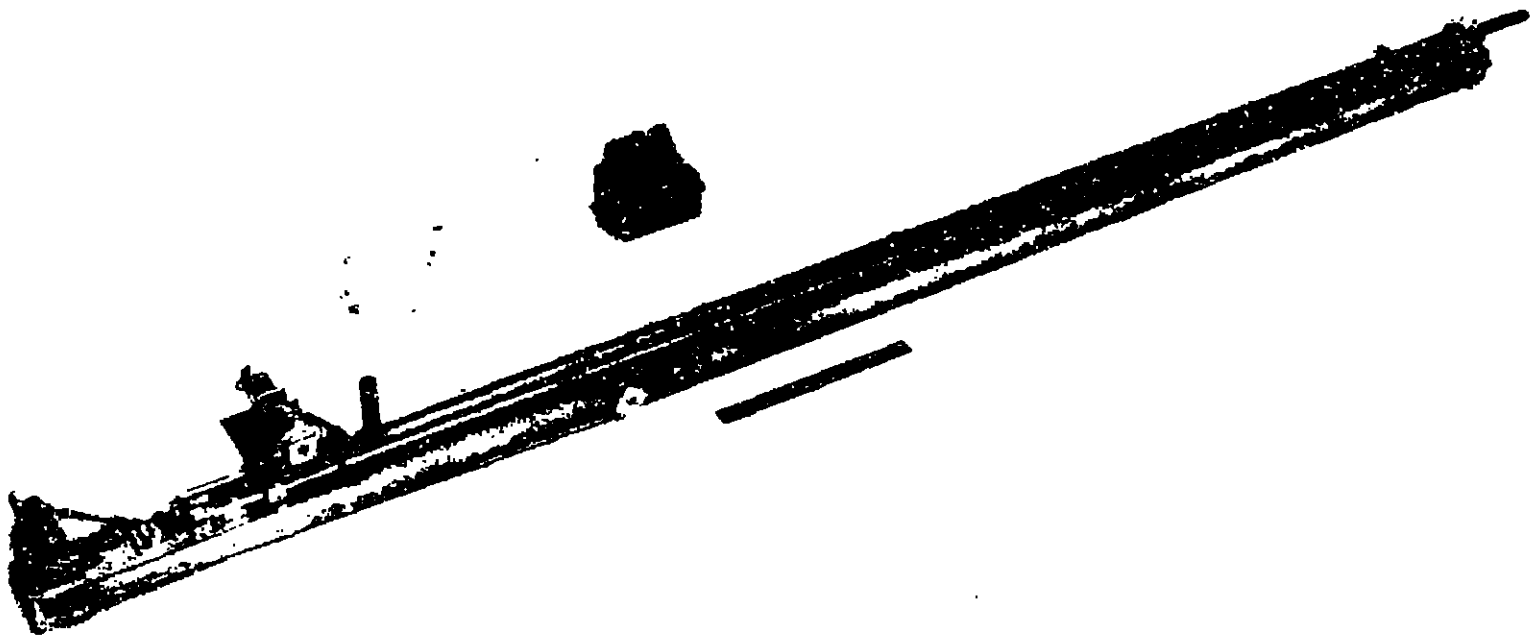

Figure 19. NEAR Sewer Sampler

Photograph courtesy of Nielsen Engineering and Research, Inc.

	proportional to water depth. Otherwise samples could be paced by a timer or arranged to accept signals from an external flowmeter.
Power Source:	Basic unit could be battery powered. External controls could require alternating current.
Sample Refrigerator:	None
Construction Materials:	Stainless steel and plastic.
Basic Dimensions:	Will depend upon length of pick-up tube; say approximately 0.3 x 0.3 x 2.4m (1 x 1 x 8 ft) plus a sample container rack. Unit must be mounted in manhole or otherwise near the flow stream. Basic unit would appear to weigh 13-18 kg (30-40 lbs).
General Comments:	Sampler is out of the main flow except when taking a sample. Developer claims sampler can pick-up a representative sample of surface oil film. Both an initial model and an improved prototype have been fabricated and tested to demonstrate the basic concepts involved, but the unit has not been made commercially available as yet. A patent has been granted for the sampler and its concept. Any requests for further information should be directed to:

S. B. Spangler, Vice President
Nielsen Engineering & Research, Inc.
850 Maude Avenue
Mountain View, California 94040
Telephone (415) 968-9457

NEAR Sewer Sampler Evaluation

1. Pick-up tube might collect debris (rags, paper, etc.) during traverse which could clog inlet port; otherwise should be relatively free from clogging.

2. Pick-up tube offers a rigid obstruction to flow while sample is actually being collected.

3. Unit would appear vulnerable to damage due to Strouhal vibration at high flow rates.

4. Movement of large objects in the flow at the time a sample is being taken could damage or even physically destroy the pick-up tube assembly.

5. Prototype does not have an automatic start feature. No self cleaning. Cross contamination appears very likely.

6. Prototype is amenable to several types of control systems, but none has been demonstrated as yet.

7. Preliminary test results indicate a capability of collecting surface oil films. Unit is unsuitable for collecting coarse bottom solids.

8. Sample container case not designed. Since unit mounts in manhole near flow surface, samples are vulnearable, and refrigeration does not appear reasonable.

9. Unit is designed for manhole operation.

10. Unit cannot withstand total immersion.

11. Unit would appear to have difficulty operating in freezing ambients.

12. Unit has design capability of operating over a fairly wide range of operating head conditions.

Designation:	FREEMAN AUTOMATIC SAMPLER
Project Location:	Columbia, Maryland
EPA Report No.:	None
Sampler Intake:	Provided by user.
Gathering Method:	External head to provide flow to sampling equipment shed. Fluidic diverters are controlled by solenoid valves by timer signals and divert flow to discrete sample containers, the flow otherwise returning to waste.
Sample Lift:	Not applicable.
Line Size:	The smallest passage in the sampling train is the 0.63 x 0.63 cm (0.25 x 0.25 in.) throat of the diverter.
Sample Flow Rate:	5.7 ℓpm (1.5 gpm).
Sample Capacity:	Modularized construction allows as many 0.9ℓ (1 qt) discrete sample containers to be used as desired. For this installation, 6 modules were arranged vertically in a single cascade, and two cascades were employed.
Controls:	Timer-actuated solenoid valves open and close the diverter control ports causing a sample to be taken at preset time intervals. Volume of sample is adjusted by positioning the vent tube in the sample jar.
Power Source:	110 VAC
Sample Refrigerator:	None
Construction Materials:	PVC pipe, fluidic diverters molded from PVC, sample containers are glass Mason jars, metal and plywood frame.

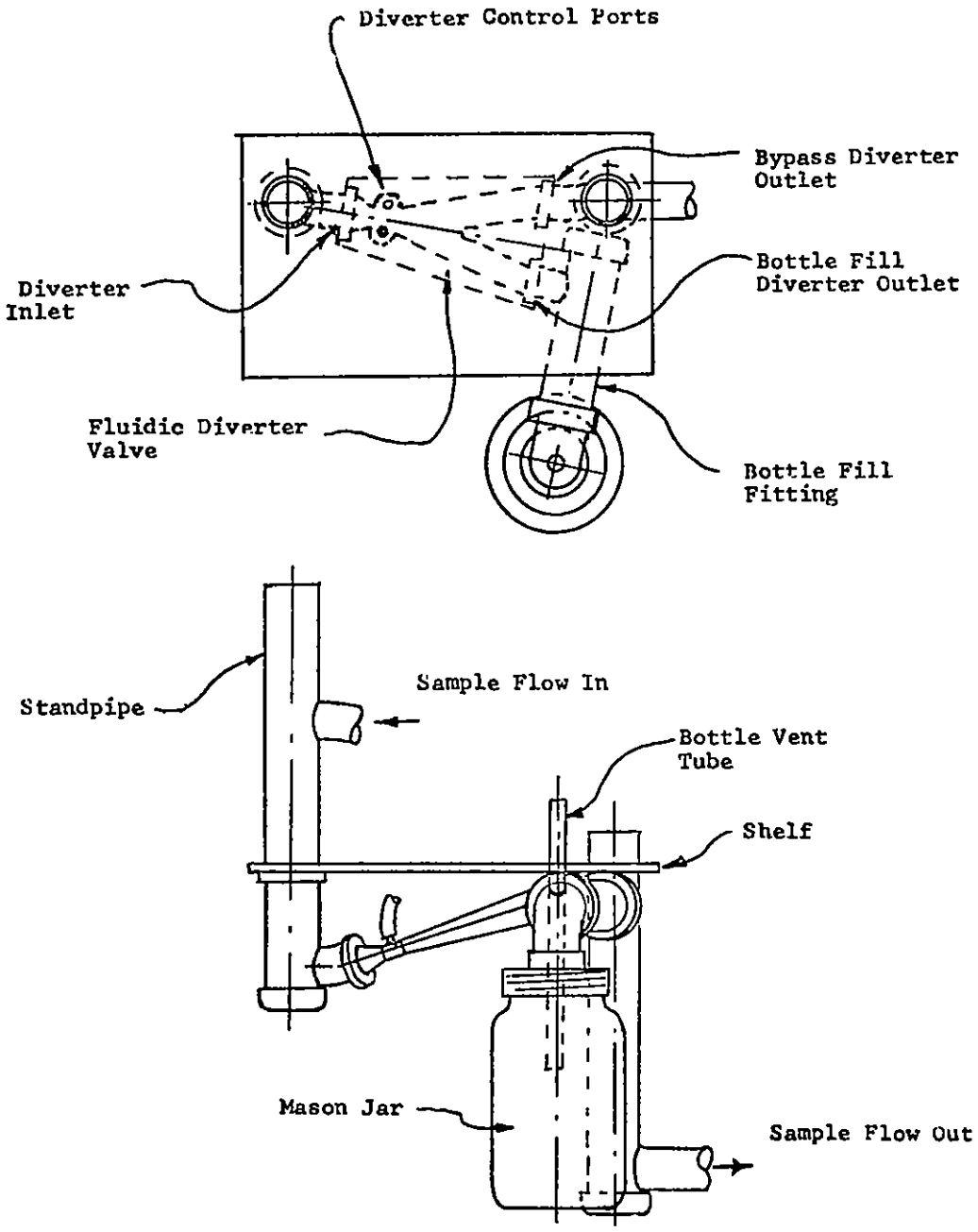

Figure 20. Freeman Automatic Sampler Module

Sketch courtesy of Peter A. Freeman Associates, Inc.

Basic Dimensions: Each 6 module cascade appears to be about 0.5 x 0.3 x 1.5m (1.5 x 1 x 5 ft). Minimum height of a module is 15.2 cm (6 in.) head required for diverter operation plus sample bottle height.

General Comments: The complete absence of moving parts in the flow stream is a distinct advantage. With the use of a bias orifice in one control port, only one control line need be blocked to obtain diversion. The possibility of using such an arrangement with the control lines sequenced vertically in a timing jar that is fed fluid by a calibrated wick would allow a sampler with absolutely no moving parts and requiring no power other than from the fluid flow itself.

Freeman Automatic Sampler Evaluation

1. Should be free from clogging. Sampling intake must be designed by user.
2. Sampler itself offers no flow obstruction.
3. Should operate well over entire range of flow conditions.
4. Movement of solids should not hamper operation.
5. Continuous flow serves a self cleaning function. No cross-contamination.
6. Collects adjustable size (up to 1 liter) discrete samples at preset time intervals.
7. Ability to collect samples of floatables and coarser bottom solids will depend upon design of sampling intake.
8. No refrigerator. Adequate sample protection for this installation.
9. Not designed for manhole operation as presently configured.

10. Cannot withstand total immersion.

11. Unit should be able to operate in freezing ambients.

12. Operating head is provided by user.

Designation:	PS-69 PUMPING SAMPLER
Project Location:	Columbia, Maryland
EPA Report No.:	None. Not developed under EPA sponsorship.
Sampler Intake:	Provided by user.
Gathering Method:	Suction lift from progressive cavity screw-type pump.
Sample Lift:	6.1m (20 ft) recommended maximum.
Line Size:	Pump will pass 0.5 cm (3/16 in.) solids.
Sample Flow Rate:	Approximately 26 ℓpm (7 gpm).
Sample Capacity:	Adjustable size discrete samples are collected in seventy-two 0.5ℓ (1 pt) glass bottles or 0.9ℓ (1 qt) plastic containers.
Controls:	Sample size is adjusted by potentiometer setting; under timer operation samples may be taken as often as every 2 minutes or as infrequently as one a day; may be paced by optional stage-discharge computer or external flowmeter. Has automatic starter and event marker.
Power Source:	36 VDC (three 12V automobile batteries of 55 amp-hr. capacity or greater) for pump motors; one standard D dry cell battery for clock.
Sample Refrigerator:	None.
Construction Materials:	Intake tubing is user-supplied; pump is Buna-N, stainless steel, carbon and ceramic; also PVC and vinyl in sampling train.

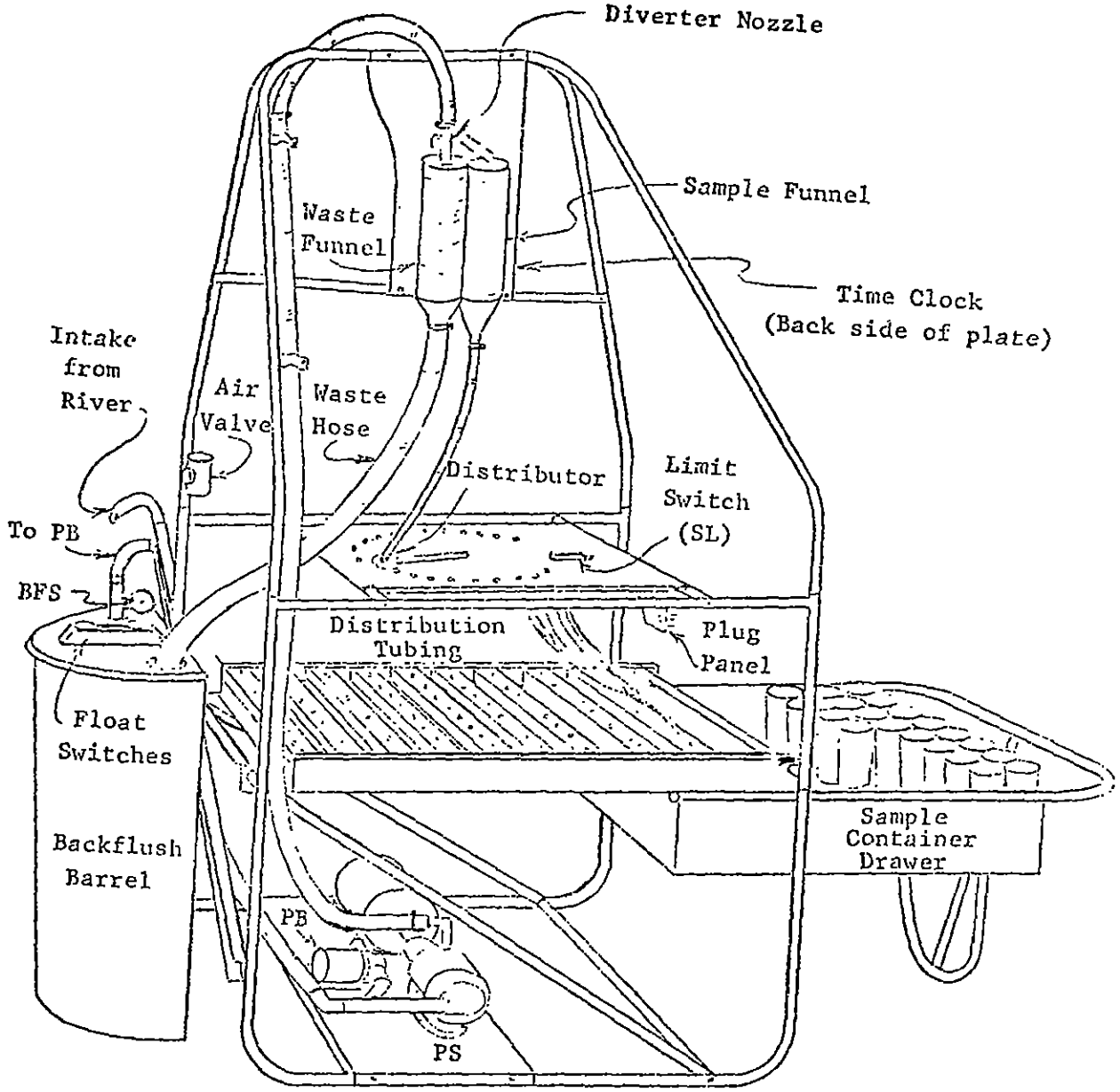

Figure 21. PS 69 Pumping Sampler

Basic Dimensions: 96 x 147 x 183 cm (38x58x72 in.); weighs 77 kg (170 lbs) without batteries or tubing; designed for fixed installation.

General Comments: This sampler was designed for sediment transport studies in rivers. A typical cycle begins with a small pump taking water from a backflush barrel and backflushing the intake, priming the line and removing any grass or trash from the intake proper. This operation continues until a bottom float in the barrel drops. When the large (sampling) pump starts, a solenoid on the backflush barrel closes the backflush pump intake and the distribution arm advances one hole. The sampling pump feeds into a solenoid operated diverter that normally feeds the backflush tank. About 20 seconds after the sampling pump starts, the diverter switches for a preset period and the sample is routed via the distributer arm and an individual plastic hose to the next sample container. The sampling pump is shut off when the top float in the backflush barrel lifts. A smaller, portable version designated PS-73 and taking 36 discrete samples is also available. Any requests for further information should be directed to:

John V. Skinner
Hydrologist-in-Charge
Federal Inter-Agency
Sedimentation Project
St. Anthony Falls Hydraulic
Laboratory
Hennepin Island and Third Ave.
S.E.
Minneapolis, Minnesota 55414

PS-69 Pumping Sampler Evaluation

1. Should be relatively free from clogging, except perhaps the tubes connecting the distribution funnels to the discrete sample bottles.

2. Obstruction to flow will depend upon way user designs and installs sampler intake.

3. Unit should be operable over the full range of flow conditions.

4. Movement of solids should not hamper operation.

5. Automatic starter; backflush of intake and inlet line provides partial self-cleaning.

6. Collects 72 discrete samples (either 0.5ℓ or 0.9ℓ) paced by interval timer, optional proportional frequency controller (stage-discharge computer), or external flowmeter.

7. Ability to collect floatables or coarser bottom solids will depend upon details of sampling intake, but anything larger than 0.5 cm (3/16 in.) will jam pump.

8. No refrigeration, but otherwise unit would appear to offer reasonable sample protection when installed in recommended shelter.

9. Unit was not designed for manhole operation.

10. Unit cannot withstand total immersion.

11. The use of a heated shelter is recommended for cold-weather operation.

12. Relatively high lift should allow operation over a fairly wide range of operating head conditions.

Designation:	RECOMAT SAMPLER
Project Location:	Paris, France (Department De Seine Saint-Denis)
EPA Report No.:	None. Not developed under EPA sponsorship.
Sampler Intake:	Four 120 mℓ tanks, each with an 8 cm (5/16 in.) diameter hole in the bottom and protected by a plastic bell, which can be positioned vertically anywhere within the flow stream.
Gathering Method:	Forced-flow due to pneumatic ejection.
Sample Lift:	10m (33 ft) maximum.
Line Size:	Smallest line is 0.6 mm (1/4 in.).
Sample Flow Rate:	Depends upon pressure and lift.
Sample Capacity:	Collects 24 sequential composite samples (1.6ℓ maximum) made up of an undisclosed (but fixed) number of aliquots of less than 120 mℓ per intake.
Controls:	The design is such that it takes 5 minutes to collect each sequential composite sample. The only control is an operator setting (η) that causes the sampler to fill the first η bottles one after the other (essentially continuous operation), after which the remaining $24-\eta$ bottles are filled at 10 minute time intervals. Thus, the total sampling period can range from 2 to 4 hours.
Power Source:	Electricity required for air compressor motor and refrigerator.

Sample Refrigerator:	Entire sample distribution and storage assembly is inside an automatic refrigerator set to maintain a 4°C internal temperature.
Construction Materials:	Sampling train is plastic and rubber.
Basic Dimensions:	Sample intake is 8 cm (3.1 in.) diameter x 15 cm (5.9 in.) H; control box is 60 x 30 x 80 cm (23.6x11.8x31.5 in.); refrigerator is 100 x 100 x 120 cm (39.4x39.4x47.2 in.); each compressor is 50 x 50 x 20 cm (19.7x19.7x7.9 in.); fixed installation.
General Comments:	This sampler was designed by RECOMAT to meet specifications written by Coyne and Bellier consulting engineers. Each intake is gravity filled, via its bottom hole, through an elastic rubber truncated cone inside its tank. The release of air pressure pinches the edges of the rubber hole and forces the sample up the line, through the distribution arm, and into the sample container. Due to air losses associated with the rubber cones (and piping), due in part to failure to shut off because of obstruction by heavy particles, only 500 mℓ or so of sample is typically obtained (rather than the 1.6ℓ design capacity). A separate air compressor is used to move the distribution arm.

RECOMAT Sampler Evaluation

1. Should be relatively free from clogging except for possibly the elastic rubber cone in the intake.

2. Sampler intakes and supporting structure present a rigid obstruction to the flow.

3. Sampling chamber will fill immediately following discharge of previous aliquot, but the use of several aliquots to obtain each sample minimizes adverse effects of this. Representativeness is questionable at high flow rates.

4. Movement of large objects in the flow could damage or even physically destroy the sampler intakes. Small solids could prevent rubber intake cone from sealing, resulting in reduced or no sample from that intake.

5. Apparently has no automatic start or self-cleaning features.

6. Collects sequential composite samples made up of a number of aliquots of possibly varying size.

7. Appears unsuitable for collection of either floatable materials or coarser bottom solids.

8. Automatic refrigeration. Cross-contamination appears likely.

9. Unit is not designed for manhole operation.

10. Cannot withstand total immersion.

11. Should be able to operate in freezing ambients for its 2-4 hour duty cycle life.

12. Maximum lift of 10m (33 ft) puts little restriction on operating head conditions but is less than in many pneumatic ejection designs.

Designation:	EG&G PROTOTYPE SEWER SAMPLER
Project Location:	Rockville, Maryland
EPA Report No.:	EPA-670/2-75-XXX to be issued soon.
Sampler Intake:	Four intakes of present configuration can be located anywhere within the flow stream. Presently consists of 4 plastic nozzles, each with three 0.5 cm (3/16 in.) diameter ports in line with the flow, mounted to a streamlined stainless steel strap around the inside periphery of the sewer pipe.
Gathering Method:	Suction lift from separate high capacity 3-rotor peristaltic pump heads for each intake, driven by a common electric motor through keyed connecting shafts.
Sample Lift:	Submersible pump box is designed to be located within 3m (10 ft) or so of the flow. Discharge heads of over 15m (50 ft) are possible.
Line Size:	Smallest line is 0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	9.5 ℓpm (2.5 gpm) through each line for 37.9 ℓpm (10 gpm) total flow in present configuration.
Sample Capacity:	Collects 12 discrete 2ℓ (0.53 gal) samples per storage module.
Controls:	May be set to take a sample as often as every minute or as infrequently as once every 9 hours, in 200 millisecond increments when paced by internal timer; may also be paced by suitable external flowmeter; has automatic start connection; all solid state design. Backflush and blowdown

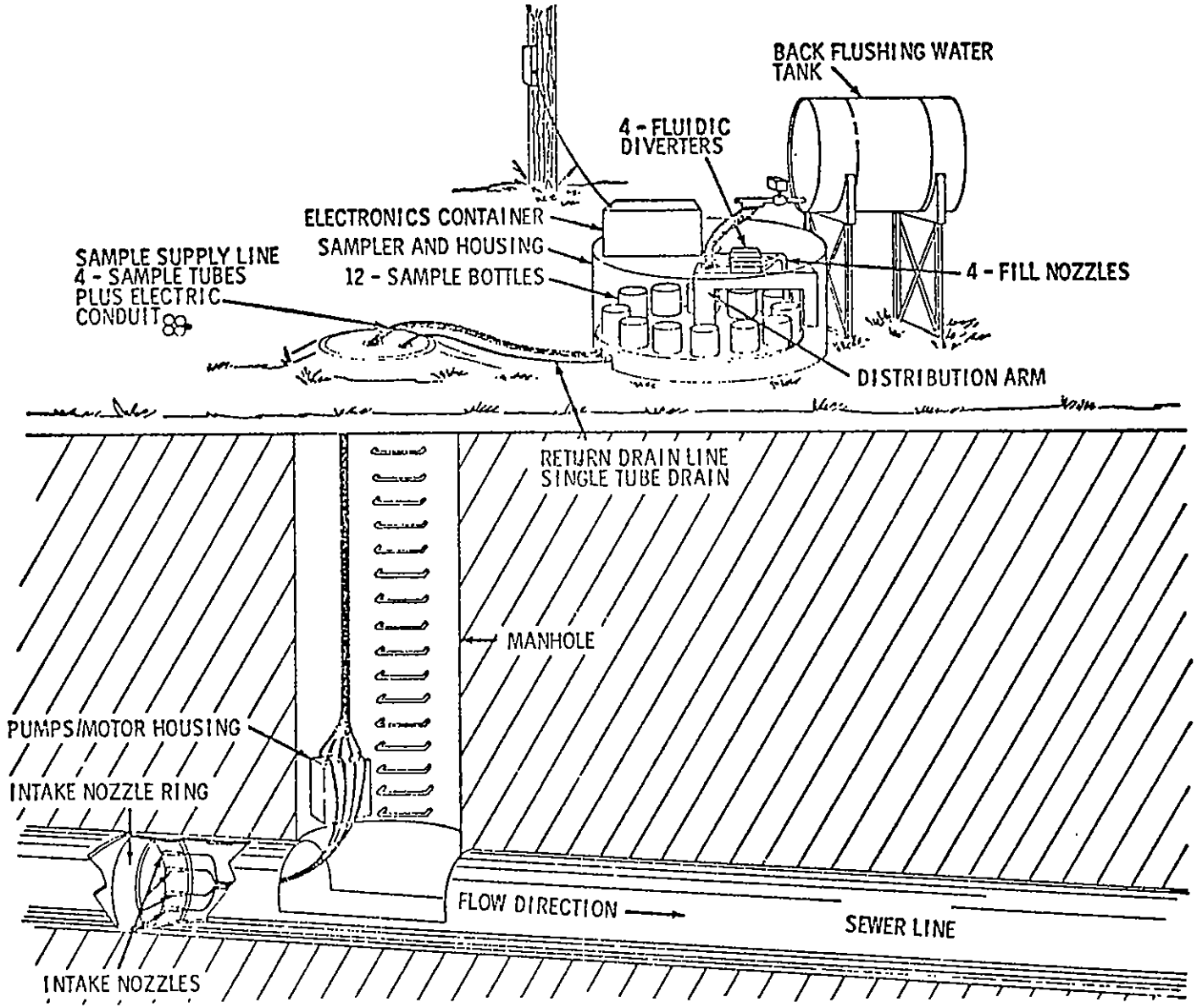

Figure 22. EG&G Prototype Automatic Sewer Sampling System Schematic

	time periods are also adjustable. Can be programmed or run manually in any fashion for test purposes.
Power Source:	110 VAC electricity.
Sample Refrigerator:	Entire sample distribution and storage assembly can be fitted with an insulated, refrigerated cover, but none is provided at present.
Construction Materials:	Sampling train is PVC, tygon, silicone, plexiglass, and polyethylene.
Basic Dimensions:	Not an integrated unit. Largest components are a standard 55-gallon drum and distributor and storage assembly which is approximately 1.2m (4 ft) in diameter and 0.9m (3 ft) H; electronics box is 47 x 39 x 30 cm (18.5x15.5x12 in.); fixed installation.
General Comments:	This automatic sampler is a prototype design incorporating several previously untried features in five modular subsystems, including all solid-state electronics, a clock to allow time-of-day correlation, high sample intake and transport velocities, large high-capacity peristaltic pumps and fluidic diverters avoiding any moving parts in the sampling train, return of the first flow to waste, fresh water or chemical purge and backflush and high pressure air blowdown after each sample is taken, multilevel sample intakes with non-intrusive mounting, and large sample capacity with the quantity of each sample determined by weight. The modular subsystem

approach allows the basic design implementation to be tailored to suit a wide variety of sampling program and site requirements.

EG&G Prototype Sewer Sampler Evaluation

1. Should be relatively free from clogging due to design of intake, lack of constrictions and moving parts in the sampling train, the fact that the sample flows under pressure from the pump all the way to the sample container, and the backflush and blowdown features.

2. Non-intrusive intake ring presents virtually no obstruction to the flow.

3. Should be capable of operating over the entire range of flow conditions.

4. Movement of solids should not hamper operations.

5. Has connection for automatic starting on signal from external sensor. Backflush, purge, and blowdown self-cleaning features should minimize cross-contamination.

6. Collects discrete samples from a multi-level intake paced by built-in timer or external flowmeter.

7. Separate intake designs required for sampling floatables or coarser bottom solids.

8. No refrigeration in present form.

9. Submersion proof pump box is designed to operate in a surcharged manhole; intake can be installed in entry line to manhole in less than 15 minutes; no other subsystems are intended to be down in the manhole; transformer isolated to prevent shock hazard if pump box is physically destroyed by accident.

10. Manhole components can withstand complete immersion.

11. Freshwater tank would require heater or antifreeze for cold weather operation. Collected samples would freeze if left for prolonged periods without a heated cover.

12. Combined lift of over 18m (60 ft) puts little restriction on operating head conditions.

SECTION VIII

EXPERIENCE WITH COMBINED SEWER SAMPLERS

In order to assess the efficacy of both standard commercially available samplers and custom engineered units in actual field use, a survey of recent EPA projects in the storm and combined sewer pollution control area was conducted. Final reports were obtained where available, but for some projects only interim reports existed and, in a few instances, telephone conversations had to be relied on. In each project, the research and development contract or grant was for an activity which also required determination of water quality. No projects had been undertaken solely to compare or evaluate samplers for use in storm and combined sewers.

STRAINER/FILTER TREATMENT OF COMBINED SEWER OVERFLOWS

Reference 9 is the final report for a project to examine strainer/filter treatment of combined sewer overflows. Although automatic sampling equipment was not used in this project, several interesting observations were made. It is stated in the conclusions that "this feasibility study has shown that sampling methods commonly used in evaluating the effect of combined sewer overflows on receiving streams cannot be considered reliable. The results indicate that most of the calculated loads that are based on automatic sampling stations have most likely understated the actual case". Particular criticism is leveled against the small diameter, low velocity probes which are characteristic of most present-day automatic sampling units. In this project the sampling was performed manually by a technician at the overflow site. Samples were taken at 15-minute intervals during the first 2 hours of flow and thereafter at 30-minute intervals for 2 hours. The samples were discrete in nature, not composites over each time interval, and were taken in two quantities: a) a 7.6ℓ (2 gal) sample taken with a 3.8ℓ (1 gal) pail, and b) a 3.8ℓ (1 gal) sample taken with a 0.5ℓ (1 pt) wide mouth cup. The samples were brought to the analytical laboratory within 6 hours of the initial sampling time.

It is noted on page 18 that visual observation of several overflows conclusively showed the presence of fresh human feces (larger than one-half inch) and whole pieces of toilet paper. Samples were also collected using a wire mesh screen

with one-quarter inch openings. Comparison of the suspended solids in the usual pail samples with those collected on wire mesh strainers consistently showed a variation in particle size. Only when a sample was taken at the surface of the flowing stream did the maximum particle size obtained with the pail equal that found with the wire mesh strainer.

In one instance a set of samples was taken by two people simultaneously at the same surface depth. The pail sample was found to have consistently higher values than the scoop sample for each variable tested. These variables included BOD, COD, suspended solids, total solids, volatile solids and settleable solids. In some instances the analyses of the scoop obtained samples resulted in values less than half of those obtained from pail-collected samples. Although whole sections of toilet paper were noted in the overflow, the sampling technique used did not produce or yield any paper in the samples.

STREAM POLLUTION ABATEMENT FROM COMBINED SEWER OVERFLOWS

Reference 10 contains the results of a detailed engineering investigation and comprehensive technical study to evaluate the pollution effects from combined sewer overflows on the Sandusky River at Bucyrus, Ohio. The overflows from many storms were sampled during the study period to determine the quality of the overflow and pollution loads. For about 6 months samples were collected manually. After February 1, 1969, Serco automatic samplers, Model NW-3, were installed in the instrument shelters at the overflows. These samplers collected a 300 ml sample every 5 minutes for 2 hours during overflow. If the overflow continued longer than 2 hours, samples were collected manually at less frequent intervals.

It is noted on page 15 that an automatic starter was devised for the samplers that started the clocks when the water level reached a pre-determined height behind the weirs. The samplers could therefore be left unattended prior to and during an overflow. The samplers required a vacuum to be maintained in the sample bottles. Because the samplers would lose vacuum after 1 or 2 days, they had to be installed in the 24 hours preceeding the overflow.

Except for these comments regarding difficulty with automatic starters and vacuum leaks, no other in-service related problems were mentioned.

CONTROL OF POLLUTION BY UNDERWATER STORAGE

Reference 11 contains the results of a demonstration project for the control of pollution by underwater storage. A pilot plant was designed, constructed and operated to assess the feasibility of providing a facility for the collection, treatment, storage and final disposition of storm overflow from a combined sewer system. A Serco Model NW-3 automatic sampler was located at the Parshall Flume. It was found to be inadequate for the requirements of the testing laboratories. The sampling quantities required were four times greater than that originally contemplated. As a result, samples were taken partly with the automatic sampler, but primarily by hand. No other comments of the suitability of this sampler for its application or experience with it were made.

ENGINEERING INVESTIGATION OF SEWER OVERFLOW PROBLEMS

Reference 12 contains the results of an engineering investigation of sewer overflow problems in Roanoke, Virginia. Both manual and automatically gathered samples were obtained during storm events to assess the quality of sewer overflows and storm runoff. Serco automatic samplers were used in this program. The problems encountered during sampling primarily involved the equipment. It is noted on page 149 that the automatic samplers worked rather well, except that some precautions had to be taken. In the streams the nozzle could not be rested on the bottom, or sand and grit would be drawn in the sample bottle. Rags from the sanitary sewers would block several of the tube openings during a 24-hour sampling program. Occasionally a clock would stop and a complete rainfall would be missed. The automatic starting devices proved to be inadequate; therefore, the samplers had to be started manually at the beginning of each rainfall which proved to be time-consuming.

MICROSTRAINING AND DISINFECTION OF COMBINED SEWER OVERFLOWS

Reference 13 contains the results of an investigation of microstraining and disinfection of combined sewer overflows. On page 20 it is noted that composite samples of the raw and strained water were extracted automatically by two N-Con Surveyor model samplers and stored in refrigerated containers. The samplers were adjusted to withdraw portions of the flows at a fixed rate every 6 minutes. The only comments made about the sampling equipment were that composite sampling is not so representative of variations within a storm and discrete samples would be more desirable, and a complaint about the low suction lift which restricted operations.

In Phase II of this project reported in (14) automatic vacuum-type discrete samplers (Serco Model SG-15) were used. The samplers collected discrete 300 mℓ samples of influent and effluent every 2 minutes. The data on organic content and coliform from 14 storms were rendered useless due to improper sterilization of the samplers in the field. Sampler failures were noted but not discussed.

STORMWATER POLLUTION FROM URBAN LAND ACTIVITY

Reference 15 presents the results of an investigation of the pollution concentrations and loads from storm water runoff in an urban area of Tulsa, Oklahoma. Standard procedures for manual sampling were used when baseline samples or stormwater runoff samples were collected. The stationary automatic sampling method was used when a time series of samples was desired. The sampling apparatus employed was unique and custom-designed for this project by the contractor. Five semi-stationary automatic sampling stations and three portable automatic samplers were fabricated and used in this project. The only problems noted were due to vandalism. Several of the semi-stationary sampling stations were broken open and some of the equipment was damaged. This caused important data losses on some watersheds.

RETENTION BASIN CONTROL OF COMBINED SEWER OVERFLOWS

Reference 16 contains an evaluation of the control of combined sewer overflows by retention in an open basin in Springfield, Illinois. It is interesting to note that the instrumentation subcontract cost was $31K, while the subcontract for construction of the basin itself only cost $77K. A rather large scale fixed installation, automatic sampling system was designed for this project. Originally 10 cm (4 in.) diameter influent and effluent sampling lines were used. Pumps took suction from the sampling lines and discharged in the sampling tanks. A Trebler scoop-type sampler was provided in each tank to take the samples. Samples of equal volume were taken at 30-minute intervals with the automatic samplers and composited over a 24-hour period The composite bottles were located in a refrigerator and were kept under mechanical refrigeration at all times.

Problems were experienced with operation of the samplers during early months of the operation. This was particularly true of the influent sampler. The influent sampling line was over 274m (900 ft) long. It was concluded that this 10 cm (4 in.) diameter line was much too large for the size pump taking suction from it and, as a result, considerable

amounts of solids settled in the line. This provided a non-representative sample of the influent. There were also difficulties associated with the location of the influent sampler probe. As a solution, the 10 cm (4 in.) influent sampling line was replaced with a 3.8 cm (1.5 in.) diameter line. This provided better velocities in the line and minimized settling of solids in it. A listing of maintenance items required over a 1-year period of operation is given on page 31. It is noted that there was one instance of repair on the flowmeter, seven instances of influent sampling line repair, one instance of effluent sampling pump repair, one instance of influent sampler motor burnout and replacement, three instances of repair for both pumps, and eight instances when the influent sampling line needed to be unclogged.

CHEMICAL TREATMENT OF COMBINED SEWER OVERFLOWS

Reference 17 contains the results of a study of flocculant treatment and disinfection of combined sewer overflows at Grosse Point Woods, Michigan. It is noted on page 48 that one of the most difficult problems was that of sampling. Flow rates varied from 8.6 to 69.4 cu m (305 to 2,450 cu ft.) per second. Influent sewage depths varied from 0.6 to 5.2m (2 to 17 ft.) with no dry well available for positive head devices, and a representative effluent sample had to be obtained from an inaccessible weir approximately 64m (210 ft.) in length.

All main sampling lines in the final design were 5 cm (2 in.) in diameter and flowed constantly during the sampling period. Because of the importance of sampling, automatic samplers were designed and constructed specifically for work on this project. These samplers were designed to collect adjustable grab samples from the continuously flowing 5 cm (2 in.) pipe stream, composite them for various periods, and hold them in a refrigerated compartment for periods up to about 3 hours. No discussion of problems encountered with these sampling devices was given.

COMBINED SEWER TEMPORARY UNDERWATER STORAGE FACILITY

Reference 18 contains the results of a demonstration of the feasibility of utilizing a temporary underwater storage facility as a means of abating pollution resulting from storm overflow from a combined sewer. Conclusion number 5 is especially interesting: "The samplers utilized on the project are not recommended for the sampling of sewage from

combined sewers. A more advanced and efficient sampling method should be developed for future programs." On page 32 it is noted that "the required volume per sample was 1,020 mℓ to perform all required analyses. The standard Serco Model NW-3 automatic sampler would collect approximately 330 mℓ of sample per bottle when operated with a 1.5m (5 ft) lift, and 66 cm (26 in.) mercury internal vacuum and an atmospheric pressure of 76 cm (30 in.) mercury. Therefore, it was necessary to fill four bottles at a time for adequate sample volume". A newly designed and fabricated tripper arm was installed on the Serco sampler. The tripper arm simultaneously actuated four sampling line switches. A 15-minute gearhead was utilized for the tests to provide a sampling interval that would not overtax the field laboratory beyond its capacity.

URBAN RUNOFF CHARACTERISTICS

Reference 19 is an interim report on investigations for the refinement of a comprehensive EPA stormwater management model in which urban runoff characteristics are to be depicted. As a part of this program, automatic equipment for sequential sampling of water quality was installed for five separate sewer locations in the Bloody Run Sewer Water Shed in Cincinnatti, Ohio. N-Con Sentry Sequential Effluent Samplers were used in this program. The large amount of data given in the report indicates a generally satisfactory collection of samples but no operational comments are given.

IN-SEWER FIXED SCREENING OF COMBINED SEWER OVERFLOWS

Reference 20 reports on a project to examine the feasibility of in-sewer fixed screening of combined sewer overflows. As a part of this effort, a field sampling and analysis program supplemented with laboratory studies was conducted to characterize combined sewage contributory to combined sewer overflows, and to ascertain the removal of floatables and solid materials that could be effected by the placement of the screening devices in these systems. For this program special sampling equipment and supporting structures were designed and manufactured in order to assure representative collection of combined sewage samples. The equipment consisted of two types of samplers: a bulk liquid sampler and a screening sampler. Both employed the same support structure and the same sampling manhole. These are essentially bulk grab samplers which allowed removal of an entire 30.5 cm (1 ft) long section of combined sewage flow in the sewer. The sampler is lowered by hand and raised by a winch. Samples were collected on an hourly basis. No comments are

made about the operational experience with these samplers, but apparently no difficulties were encountered.

STORM AND COMBINED SEWER POLLUTION SOURCES AND ABATEMENT

Reference 21 is a report on a study of six urban drainage basins within the city of Atlanta which were served by combined and separated sewers. As a part of the effort to determine the major pollution sources during storm events, automatic sampling devices were used. The Serco Model NW-3 Sampling Device was used, but several difficulties are indicated. On page 4 several interesting conclusions are noted: "Samples collected by automatic sampling devices tended to freeze in the sampling tubes during cold weather. Furthermore, the location of these vacuum operated devices at safe heights above peak flow levels limited the volume of samples that could be collected." "The automatic triggering device utilized during this study was not reliable. Dampness deteriorates electrical contacts and solenoids causing failure of apparently well insulated parts. The consequent necessity for manual triggering of the automatic samplers reduces their usefulness and indicates the need for an improved triggering device." "No significant differences exist between water quality analyses of simultaneous samples obtained by grab and automatic sampling techniques."

STORM WATER PROBLEMS AND CONTROL IN SANITARY SEWERS

Reference 22 is a report of an engineering investigation which was conducted on stormwater infiltration into sanitary sewers and associated problems in the East Bay Municipal Utility District with assistance from the cities of Oakland and Berkeley, California. Grab samples were collected with a rope and a bucket. Wet weather samples were collected with an Edison Lever Action Diaphragm Pump with a 3.8 cm (1.5 in.) suction line. Two types of portable samplers were used for dry weather flow; the Hinde Effluent Sampler which has a positive displacement pump with a 6m (20 ft.) lift and an N-Con Surveyor automatic composite sampler. The only real difficulty encountered in using the automatic samplers was that the suction tubing was so small that stringy and large size material tended to plug the lines. This problem was circumvented by placing a 20-mesh galvanized wire fabric stilling well around the ends of the suction tubes. Also, it was not possible to obtain samples automatically at one location because its 7.3m (24 ft.) depth exceeding the lift capacity of the samplers. It is noted on page 61 that the results of the analyses which were conducted on the samples gathered with the automatic sampling equipment were somewhat erratic.

UNDERWATER STORAGE OF COMBINED SEWER OVERFLOWS

Reference 23 is a report of a demonstration study of offshore underwater temporary storage of storm overflow from a combined sewer. It is interesting to note that one of the recommendations given on page 3 is that, "collection of grab samples of all flows should be used liberally to confirm results from automatic samplers." The sampling program included grab samples for the dry weather flow, individually timed samples and composite samples of the storm overflow from the combined sewer drainage area, composite samples of effluent from the storage tanks, and grab samples of bay water at the outfall. At the time of design no sampler was commercially available to do the required job and at the same time secure a representative composite sample. Therefore a sampler was designed and constructed especially for this program. No operational data regarding this sampler are given but apparently no great difficulties were encountered.

MAXIMIZING STORAGE IN COMBINED SEWER SYSTEMS

Reference 24 is a report on maximizing storage in combined sewer systems in the municipality of Metropolitan Seattle. Programmed automatic-refrigerated samplers were designed and built as a part of the demonstration grant to simplify the sample collection tasks. These were manufactured by Sirco and were their Sewer-Test Vary-Sampler models. The report notes that, "the connotation of the term 'automatic' is somewhat deceiving; considerable manual effort is involved in collecting samples, replacing bottles and testing and repairing the various electrical components". Originally the samplers were supervised, maintained and serviced by different personnel. On the newly designed samplers, there was a 6-month period during which the samplers were broken in and various parts changed or modified. A single technician was assigned supervisory, service and maintenance responsibility for each of the automatic samplers and, since then, performance has been satisfactory.

A number of sampler problems were encountered including the electrical system which was quite complicated, the wiring which was difficult to maintain, instances of inadequate fuses, and failures of timers, microswitches, relays and reed switches. It is also noted that despite an automatic purging feature, the 0.95 cm (3/8 in.) diameter sampling tubes often became clogged with rags and other debris and required constant checking. During periods of extremely high flows, the sampler tubes were often flushed over emergency overflow weirs and left hanging high and dry when the flow subsided.

After the reporter's extensive history with the use of these samplers, two of the conclusions were especially noteworthy; "Samplers and recorders to be effective require regular surveillance and maintenance. The smallest failures can reduce valuable data to a level that is unuseable for certain statiscal analyses." "The best sampling equipment is generally the least complex, is portable, does not require lines, constrictions, or bends, and is not likely to become damaged when submerged (a large order)."

OTHER EPA PROJECTS

Among EPA projects surveyed for which final reports are not available is a project (EPA No. 11023 FAT) for the construction, operation and evaluation of a stormwater detention and chlorination station to treat combined sewer overflows on the Charles River in Boston, Massachusetts. Operation of the station commenced in early summer of 1970. Two Pro-Tech, Inc., Discrete Flow Samplers, Model DEL-240, are installed for obtaining discrete samples of inflow to the plant. These can be adjusted to sample at various time intervals from 1 minute to 24 hours. In a recent telephone conversation with the engineer in charge of the facility, it was learned that numerous troubles were experienced with the samplers during early operation. After various adjustments and modifications by the manufacture, the samples operated satisfactorily. The specific nature of the troubles experienced was not discussed.

In a project (EPA No. 11023 FAS) for the chlorination of a large volume of stormwater draining to Lake Pontchartrain in Louisiana, seven samplers were designed and constructed specifically for the project. Difficulty was experienced with solenoid operation of a brass valve. Apparently, satisfactory operation was attained after redesigning the valve in PVC. Initially, a telephone tone was used to start and stop the samplers. This method of actuation did not prove to be satisfactory and was discontinued. Information concerning these samplers was obtained by telephone conversation with the project engineer.

In a project (EPA No. 14-12-24) for the demonstration of a method of treating municipal sewage with a deviced termed a "rotating biological contactor", Serco automatic samplers were used for sampling in the treatment plant. Apparently, under the controlled plant conditions, performance of the sewer samplers was satisfactory. A "rotating belt sampler", custom built for the project, was used to sample wet weather flows to the plant. Samples were obtained "by means of a

mechanical sampler installed in a drop manhole in the street. A series of sampling cups was driven along a belt to collect 250 ml samples about every 15 minutes during the combined flow. The sampler was actuated by the flow measuring device and was stopped by a limit switch when the first sample reached the drive system near the top of the manhole. Records collected for the project show that the device operated on 18 days during periods of fairly small flow, usually under 283 lps (75 gps).

In a grant project (EPA No. 11023 DXC) for the characterization and treatment of combined sewer overflows in San Francisco, California, a unique partially hand sampling device was used. A 30.5 cm (12 in.) pipe core, set in pipe guides, is dropped to the bottom of the channel with its cover open. Thus a partially integrated sample is forced into the pipe. The cover is then closed and the sample is surfaced by means of compressed air.

In a grant project (EPA No. 11020 FAX) to demonstrate system control of combined sewer overflows in a large urban area, an automatic sampler manufactured by Rock and Taylor of Birmingham, England, was used. Megator Corporation, Pittsburgh, Pennsylvania, is distributor of the sampler. It is of suction type with a maximum lift of 5.5m (18 ft) operating on a 12-volt battery or 120 VAC. Performance of this sampler was continually troubled by blockage due to papers, rags, disposable diapers, etc. Such troubles are described in project reports during most months of operation. After a period of freezing during the winter, use of the automatic sampler was discontinued, and hand sampling was substituted.

In a grant project (EPA No. Y-005141) the Rochester Pure Waters District has the overall responsibility for a comprehensive, on-going combined sewer overflow abatement program in Rochester, New York. District is directing its efforts towards an abatement program for the combined sewer overflows within its system, under which, management and control of the total system can be identified, characterized, modeled, designed, and demonstrated. The program is intended to tie together all aspects of collection, transmission, and treatment of combined sewage under a central control and management system. Within the total program is a subprogram for overflow monitoring and characterization. Measurements are being made at thirteen overflows and four interceptors.

The samplers installed at each overflow location were manufactured by Sigmamotor and are similar to their Model WM-5-24. Modifications in the sampler package were necessary to meet the head conditions at each location. For those overflow